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*"To the solid ground
Of nature trusts the Mind that builds for aye"* —WORDSWORTH

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# DATES and PAGINATION of WEEKLY ISSUES

| *Serial No.* | *Date of Issue* | | *Pagination* |
|---|---|---|---|
| 3896 | July | 1 | 1–34 |
| 3897 | ,, | 8 | 35–62 |
| 3898 | ,, | 15 | 63–96 |
| 3899 | ,, | 22 | 97–124 |
| 3900 | ,, | 29 | 125–158 |
| 3901 | August | 5 | 159–186 |
| 3902 | ,, | 12 | 187–220 |
| 3903 | ,, | 19 | 221–248 |
| 3904 | ,, | 26 | 249–282 |
| 3905 | September | 2 | 283–310 |
| 3906 | ,, | 9 | 311–344 |
| 3907 | ,, | 16 | 345–372 |
| 3908 | ,, | 23 | 373–406 |
| 3909 | ,, | 30 | 407–440 |
| 3910 | October | 7 | 441–468 |
| 3911 | ,, | 14 | 469–496 |
| 3912 | ,, | 21 | 497–524 |
| 3913 | ,, | 28 | 525–558 |
| 39[illegible] | November | 4 | 559–586 |
| 39[illegible] | ,, | 11 | 587–620 |
| 39[illegible] | ,, | 18 | 621–648 |
| 3917 | ,, | 25 | 649–682 |
| 3918 | December | 2 | 683–716 |
| 3919 | ,, | 9 | 717–744 |
| 3920 | ,, | 16 | 745–778 |
| 3921 | ,, | 23 | 779–806 |
| 3922 | ,, | 30 | 807–840 |

# INDEX

## NAME INDEX

# SUBJECT INDEX

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## CONTENTS



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# CARTOGRAPHY AND THE UNIVERSITIES

THE primary concern of geography is to take accurate note of the spatial relationship existing between environmental phenomena which are significant in the organized life of mankind, and its philosophy is devoted to interpreting the interaction of man and his habitat. Cartography has a special and close relationship with geography.

Modern geography is becoming more and more an exact science using quantitative methods in regional analysis. To studies of this kind the map, chart and diagram are fundamental and, because of this, cartographical studies rightly occupy an important place in the geographer's training. The map is the geographer's chief tool. In its simplest conception it is a conventionalized representation of some aspect of the earth's pattern so that the larger patterns are reduced in such manner that they can be comprehended in one person's view. The geographer seeks to interpret, understand and account for the facts displayed. To bring these fundamental materials for study into existence, two phases are involved. First there must be measurement by the *surveyor* of the elements of the total environment that are to be portrayed : the configuration of the land or of the sea bottom, the weather, climate, geology, social, cultural and demographic features, etc. The organized measurement of the elements of environment is properly the work of specialists such as the topographical and hydrographic surveyor, the meteorologist, geologist, economist, anthropologist and so on, each developing a high degree of specialist skill in technique and refinement of equipment, and also often finding government authority and support necessary for the adequate performance of their duties. This being done, it is the *cartographer's* business proper to collect and use these measurements, and render the data in such a way that they may be accurately and fully but clearly depicted. Many sciences provide the cartographer with his material, and although he is not primarily concerned with observational practice, yet he must possess a knowledge of the methods of the sciences sufficient to enable him to check or appraise the value of the data supplied.

A geographer intending to carry out his own investigations into man's physical environment and his relationship with it will often need to make his own measurements, and though he may not do so with the refinement and equipment of the professional specialist surveyor or investigator, he will none the less be using exactly the same methods and principles. The geographer, too, needs to be able to give clear and correct graphic expression to his ideas. Hence a knowledge of, and some working practice in, the methods, technique and limitations of both the survey and cartographic aspect become essential if the geographer is to obtain and give a true interpretation of the information he is handling.

In order to ascertain if adequate training were being given in these aspects, it was decided after a discussion during the Cambridge meeting in 1938 of the

British Association for the Advancement of Science, that the Conference of Heads of University Departments of Geography should endeavour to obtain information about cartographical work conducted in British universities and the universities of the Empire. A *questionnaire* on 'laboratory work' was accordingly drawn up and sent out to departments of geography in the various universities.

So far as the universities of Great Britain are concerned, it is probably true that most departments devote an adequate amount of time to cartographical studies, such work representing 30–40 per cent of the geography time-table in each of the three years of an honours degree course. But generally speaking, the topics treated are very similar, resulting in a surprising lack of differentiation among departments which in other ways work on distinctive lines. The general scheme is practical map work, map reading and the interpretation of topographical sheets; the cartographic analysis of maps (British and foreign) on different scales; the cartographic representation of economic and other statistical data; geological, meteorological and climatological maps, and exercises based on them, and varying amounts of surveying. No doubt the quality of the cartographic work could be improved, but this would be conditional on equipment and properly qualified staff being available.

That cartography in university departments of geography in Great Britain has been thought mainly to consist of map reading and interpretation, an understanding of the properties of different projections, the elementary methods of survey and the construction of statistical maps and diagrams is understandable, in that these ought, if properly taught, to provide the geographer with a training sufficient to enable him to carry out simple surveys and to use and appreciate maps scientifically. The major deficiency in the courses offered lies in the paucity or absence of training in those special techniques, judgment, style, etc., that characterize the range of operations that must take place between the completion of the survey and the placing of the published map or chart in the hands of the geographer.

An improvement in the quality of cartographic instruction could be secured without an extension of time already devoted to this side of the geography course by the adoption of a carefully thought out syllabus which would ensure that all aspects of cartographic studies receive adequate treatment—all important branches of surveying, office compilation and drawing and map production as well as map use and interpretation. In suggesting improvements for the geographer, the possibility of building up, on this foundation, courses which will cater for the needs of the specialist cartographer should not be overlooked. Before the War no advanced course of cartographical studies could be taken in any British university. At Cambridge, instruction in advanced topographic and geodetic surveying was available in Part II of the Geographical Tripos; but this course was largely designed for intending entrants into the Colonial Survey Service, and as such was not concerned with the preparation and production of maps and diagrams recording all the elements in man's environment and his activities in economic, social and political affairs.

The incidence of war has created an increased demand for the specialist cartographer. Government departments have had serious difficulties in satisfying their requirements, and on occasions it has proved impossible to find people adequately trained for cartographic posts. A demand for the services of trained cartographers exists not only in the older Government departments producing maps and charts from fundamental surveys, but also in the newer ministries now largely concerned with the work of planning and reconstruction. The oldest department is the Ordnance Survey (dating back to 1791), and this is charged with the responsibility of the national survey, from cadastral maps to general-purpose sheets on smaller scales. The staff is partly civil and partly military, the latter filling the higher posts and being trained at Royal Engineers schools such as Woolwich and Chatham.

Of a somewhat similar vintage is the Hydrographic Department, founded in 1795, which is responsible for the preparation of charts for the Royal Navy and merchant fleet. Here again service and civilian personnel are to be found, but there is a more rigid demarcation of duties: office and production work is largely a civil matter, the hydrographic survey being undertaken by naval personnel of the surveying service.

The comparable unit in the War Office is the Directorate of Military Survey and Geographical Section General Staff, which dates from 1855. Originally the section had an imperial function, as it was largely responsible for the preparation and production of maps of the Colonies and other poorly surveyed parts of the world in which Great Britain had a special interest. This work has diminished, however, as each Colony and Dominion has taken over its own survey, and now the organization is chiefly concerned with the compilation and supply of maps to the Army; it has recently acquired the responsibility for the preparation and supply of aeronautical maps to the Royal Air Force. Like the Ordnance Survey, its staff is partly civil and partly military, the latter being drawn from the Royal Engineers.

The newer departments, the development of which has demanded, or might demand, cartographic staff, include the Ministries of Home Affairs and Home Security, Information, Town and Country Planning, Transport, Health, and Agriculture and Fisheries, and the Board of Trade.

In the war-time expansion of activity, the Service departments have looked to the universities for suitably trained 'specialists'; but not having recruited personnel from them hitherto, there were no specialist courses, and apart from those teaching cartography in the schools of geography few were found. The situation in the universities of Great Britain is now generally worse than before the War; but one advantage at least has accrued, in that a close knowledge of the needs of these departments has been gained by the university teachers absorbed into them.

Two broad conclusions emerge. In the first place, there are undoubted grounds for an improvement in quality of the cartographical training made available for geographers. Secondly, in view of the probable continued post-war need for specialist cartographers —personnel best recruited from geographers with a good mathematical training—it seems likely that the Government departments will look to the universities of Great Britain when making such professional appointments. It is therefore not too early to consider an investigation into the probable needs of these departments and the possibility of meeting such needs, not only by the desirable general raising of the standard of cartographical teaching, but also by the creation of advanced courses at selected universities.

## A SHORTER HISTORY OF SCIENCE

A Shorter History of Science
By Sir William Cecil Dampier. Pp. x+190+9 plates. (Cambridge: At the University Press, 1944.) 7*s*. 6*d*. net.

SIR WILLIAM DAMPIER has now published a shorter and easier version of his very successful "History of Science". In the preface he says that the readers he has in mind are, first, that rather elusive creature the 'general reader', and second, those more definable readers who occupy the higher forms of schools. They will either be science students whose science can be broadened, or students of the humanities who need an idea of the place of science in human life. The book should fulfil these requirements very well indeed.

The new volume is less than a third of the length of the earlier one. Thanks to narrow margins, no references in footnotes and thin paper, it can be put into one's pocket. In spite of this, the print is clear and not crowded, and room has been found for nine plates. Six of these are portraits of men of science —Archimedes, Leonardo da Vinci, Galileo, Newton, Darwin and Rutherford. The first portrait is perhaps not very authentic. The last is authentic enough, but is a photograph with that strained expression often seen on passports and not at all characteristic of Rutherford.

The process of compression has been carefully done. By omitting minor lines of investigation and the work of minor contributors, the account has on the whole been made more readable, without any great loss for a book that is not meant to be a work of reference and that supplies a good select bibliography. There is less philosophical discussion but enough to give an outline of that aspect of scientific thought. Parts have been rewritten and some definitely improved, but of course a good deal of the compression has been a matter of scissors and paste. The earlier chapters up to the end of the eighteenth century are highly successful. If the later ones are not quite so good, that is because the immense mass of detail to be considered raises much harder problems. In a few cases compression has gone to the length of obscurity, as in the solitary mention of the work of Langmuir and Adam on surface films (p. 135). The statement about von Baer, the embryologist, at the end of p. 114, has become misleading by the omission of statements that explain and qualify it in the larger book. The probability curves shown on pp. 96 and 124 without adequate explanation in the text or under the figure are likely to mystify the innocent reader. This is specially to be regretted, as these curves come into a host of modern problems. Still, these are minor blemishes and there do not seem to be many of them.

For the majority of readers, who are not going to be scientific specialists, but who want a conspectus of the development of scientific thought and practice, the book seems admirably fitted. For those young people who are going to devote themselves to scientific investigation it has one defect, though one it shares with almost anything they are likely to read about the progress of science. That is, that this progress is made to look like an unbroken series of triumphs. Before long these people will discover that the experimental method consists in doing fifty things wrong before doing one right. It might be a help to them (to mention one case only) to hear how it happened that "the incomparable Mr. Newton" himself made one serious mistake and devoted years to chemical experiments which yielded no results. There is no need to go to the other extreme of the cynic who said that "science consists of theories, which nobody believes except the man who first thought of them, and facts, which everybody believes except the man who has last investigated them". Nevertheless, the young do tend to take a rose-coloured view of things, and it is part of the duty of their elders to disabuse them. A. D. RITCHIE.

## BIBLIOTHECA CUSHINGIANA

The Harvey Cushing Collection of Books and Manuscripts
(Publication No. 1. Historical Library, Yale Medical Library.) Pp. xvi+207. (New York: Schuman's, 1943.) 8.50 dollars.

WHEN Prof. Cushing bequeathed his remarkable library to his old University of Yale, he set aside a fund to be used in cataloguing portions of the collection. The advisory board of the historical library, however, decided to employ this fund in preparing a short-title list of the *entire* collection. Whether it was advisable to do this, instead of concentrating on a list of only the rarer and more important items, *with full collations*, was doubtless considered. Cushing's bio-bibliography of Andreas Vesalius, published posthumously, does indeed include such collations of the relevant Vesaliana, and this to some extent favours the decision of the members of the advisory board, who were not in a position to ignore considerations of expense, or to indulge in duplication. Prof. J. F. Fulton, who is devoted to the memory of Cushing, and is himself a learned and experienced bibliographer, favoured the solution adopted, and it will be wise to respect his judgment, although a volume comparable in plan with the Bibliotheca Osleriana would have been most welcome.

The library includes 77 early manuscripts, 168 *incunabula*, and some 7,500 books, pamphlets and separates. It is therefore not a large collection, but on the other hand it is relatively very rich in the rarest and most desirable works. To assemble such a library, in times when it was possible, postulated the possession of ample means, of knowing what to

buy and how to find it, and above all of a dogged pertinacity almost superhuman. All three conditions were abundantly exemplified in Cushing and his friend Osler, and the result was the formation of two of the most notable private scientific libraries of modern times. A few of Cushing's rarities, apart from his unique collection of Vesaliana, are: Aselli on the lacteals, 1627; Berengarius' Isagoge, 1522; Caius on dogs, 1570; Canano on the muscles, 1541; Coiter's comparative anatomy, 1573–75; Dryander's anatomy, 1536–37; Estienne's anatomy, 1545; Harvey on the circulation, 1628; Mondinus' anatomy, 1538; Rabelais' Pantagruel, 1546; Redi on insects, 1668; Vicary's anatomy, 1587; and Wolff's Inaugural Dissertation, 1759. There are, of course, notable gaps, some of which are surprising, since they could have been readily filled. Such are Haller's "Bibliotheca Anatomica" and "Elementa Physiologiae", both of which Cushing must have frequently consulted. Havers on the bones, Tyson's chimpanzee, Willis on the soul of brutes and the "Acta Medica Hafniensia" are also wanting.

The volume has been very well printed on good paper and is suitably bound. F. J. COLE.

## WEST INDIAN ARCHÆOLOGY

### Yale University Publications in Anthropology, Nos. 25 and 26

The Ciboney Culture of Cayo Redondo, Cuba, by Cornelius Osgood; Archeology of the Maniabon Hills, Cuba, by Irving Rouse. Pp. 252+14 plates. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1942.) 23*s*. 6*d*. net.

THE two areas of excavation under review lie to the west and east of Cuba respectively. Cayo Redondo is a swamp island close to the sea at the head of Guadiana Bay; the Maniabon hills have yielded a number of kitchin midden sites and a cave habitation. Everything earlier than the coming of the Spaniards is, of course, prehistoric, and the early story of Cuba has still to be written in detail. But the generalized outline is known and much suggestive information can be obtained from the volume under review.

It would seem that at some unknown date—perhaps during the first millennium of our era—a people from North America filtered into the "islands" and occupied Cuba. They have been called the Ciboney. Very similar to them in all main characteristics were the so-called Guayabo Blanco folk. The Ciboney introduced a very primitive culture and practised neither agriculture nor manufactured pottery. Any manifestation of art, too, is absent. Their material culture seems to have consisted mainly of objects made from shell and rough stones. Ochre, however, has been discovered, so they may have painted themselves. Their burial ceremonies are unknown though they may have deposited their dead in caves.

At a somewhat later date tribes of the Arawak group, perhaps impelled by the Caribs, penetrated up from South America and occupied most of Cuba, leaving little but small, unhealthy areas on the western coast to the earlier Ciboney. The Maniabon Hills' sites, while yielding a little Ciboney material, have mostly yielded objects left by the newcomers, and the Ciboney probably had to quit. The invaders fall into two groups chronologically, named respectively the Sub-Taino culture and the Taino culture. They practised agriculture and made pottery. This at first was beautifully decorated, but later became poorer in quality and plain. The Caribs arrived just before the Spaniards, and would doubtless have overrun both the earlier Ciboney and the Taino groups if the Europeans had not arrived in time to mop up everything themselves. Anyone interested in the "pre-conquest" Indian cultures of the West Indies should peruse this work. It is well illustrated. M. C. BURKITT.

## A STUDY OF FREEDOM

### The Machiavellians

Defenders of Freedom. By James Burnham. Pp. v+202. (London: Putnam & Co., Ltd., 1943.) 7*s*. 6*d*. net.

MR. BURNHAM is well known as the author of "The Managerial Revolution". He remarks, with a certain bitterness, of the present book that its circulation is not likely to be large. I am not sure whether Montaigne, who held himself detached from the civil wars of his day, may not have had a richer wisdom than Machiavelli; but Mr. Burnham feels that the Florentine, and his successors of the too little known Italian school, Pareto, Michels and Mosca, require this volume of homage. For Mr. Burnham's attempt to develop still further an authentic political science, following in the way of the Chicago school and its derivative, Bertrand Russell, too high praise can scarcely be given.

The thesis, of course, that the appetite for power rather than the economic appetite provides not only the major but also the master key to the interpretation of political action is, as this writer can testify, not new and will to-day be found even in the writings of Russian Marxists. An eminent Left Wing weekly journal recently, in reviewing Mr. Burnham's book, commented sub-acidulously that it made no contribution to scholarship. We may reasonably suspect that we have here a psychological defence reaction, for which doubtless Pareto would find a technical name. The fact is that the Marxists, under pressure of the results of recent psychological and anthropological research, are in full strategic retreat from their earlier material dogmatism, and the franker among them are prepared to admit that new light is possible since Marx. Our major risk is to be told that Marx invented Burnham's power theory as well as all the rest.

Mr. Burnham, in elaborating the predominance of the quest for power over the specific quest for control of the means of production as social determinant, supports his case by a historical survey from Machiavelli to Mosca. Recent American attention, not least under the guidance of Prof. Henderson, to the modern Italian school is noteworthy. In his "Managerial Revolution" Mr. Burnham gave reason to doubt whether the world is moving in the direction of "a free, classless, international society", and many events (not least in the U.S.S.R.) which have taken place since he wrote serve to bear him out. Like most pioneers, he perhaps overstressed his argument and minimized the difference caused not only by the rise to power of new families in that country, but also by the liquidation of old families compared with the managerial situation (at least at present) in western Europe and America. That is, the Communist

Revolution (like the French *bourgeois* Revolution) may be not only more real but also more distinctive, compared with the National Socialist, than he supposes. It does not, of course, follow that it is more equalitarian in its present structure, although even here the traditional Russian ideology is ambivalent (Leninist and Tsarist).

Similarly in his present brief and readable book Mr. Burnham (who, incidentally, is lecturer in philosophy in New York University) tends to overplay his argument. "Despotism is more nearly than freedom in accord with human nature" is but a half-truth. History, indeed, shows political individual freedom (usually destroyed, Aristotle observed, by popular movements in favour of majority will, leading towards tyranny) to be rarer than political authoritarianism of a pronounced type. But Pavlov's thesis that freedom is a conditional reflex or instinct remains undestroyed. All that happens is that, when men come to put first social security, the impulse for freedom—as distinct from the bellicose desire for tribal anarchy—takes other than civil forms, and leads men into the desert solitudes. Mr. Burnham's phrase involves a false antithesis and, taken precisely, will not stand up to criticism. When Mr. Burnham says that there is a universal "trend to Bonapartism", in part precipitated by the coming of war, nationalism and democratic economic needs, but not to be removed by the end of war, he is on safer ground and I agree with him. Certainly every sociologist and politician (including Mr. Cordell Hull) will be benefited by reading this highly stimulating and hard-hitting book, even if in conclusion he says, as did Mr. Hughes of Clemenceau's statement that Hughes was once a cannibal, "the report has been greatly exaggerated". Let us avoid cant. Certainly, if democracy is not to end in popular personal dictatorship (as it now shows signs of doing, not unexpectedly, in France) let us avoid cant, including the cant (of which Dr. Eric Fromm, in the "Fear of Freedom", warns us) which will not admit that many men dislike all liberty save their own.

GEORGE CATLIN.

## FRESHWATER FISHES OF CHINA

**The Fresh-Water Fishes of China**

By John Treadwell Nichols. (Central Asiatic Expeditions: Natural History of Central Asia, Vol. 9.) Pp. xxxvi+322+10 plates. (New York: American Museum of Natural History, 1943.) 9 dollars.

THE Asiatic Expeditions of the American Museum of Natural History have brought together general collections of freshwater fishes from representative localities in China, and this monograph by Dr. Treadwell Nichols, curator of recent fishes, reports on these collections. The scope of this most useful work is, however, much greater than this. Its aim is a comprehensive review of the freshwater fishes of China proper, and it should serve as a handbook to the subject. Outlying territories such as Manchuria and Mongolia are not included. China proper is more or less of a unit faunal area which may be divided into smaller areas and sub-areas. The freshwater fishes are separated into north-central and southern sub-faunas having a standard climatic zonal basis.

Carp-like fishes dominate the Chinese fauna. In a list drawn up by Nichols in 1928, 263 of the 374 species recognized (70 per cent) were carps and loaches (with one sucker) and 11 per cent of the remainder were cat-fishes, so that only 19 per cent belonged to non-ostariophysine groups. Carps are fundamentally non-predacious, feeding on small animals and even on vegetable matter, and are without teeth in the mouth. They have, however, well-developed, variously specialized teeth on the pharyngeal bones (of the throat). In the suckers the pharyngeal teeth are more numerous and arranged in a comb-like series.

The suckers are usually held to be more primitive than, and more or less ancestral to, the carps. One true sucker only is left in China (Myxocyprinus). According to the author one may suppose that the suckers have run their course in China, leaving this peculiar representative behind, and that they have been superseded by the present-day gudgeons, a division of the true carps. The suckers are now almost exclusively North American. This view would make of China a recent centre of differentiation and distribution for carp-like fishes. The true carps are here not only very abundant but also more varied than elsewhere and more advanced in evolution or radial differentiation. Breams, with a single primitive genus in North America and a couple allied to it in Europe, and gudgeons, which seem not to have reached Africa or America but are represented by a few species in Europe, form two sub-families with many genera and species.

Carp-like fishes are the dominant freshwater fishes of the northern hemisphere. Their present distribution is recent, from the north from an Asiatic centre, probably China. The distribution of loaches parallels that of carps. They are probably a secondary offshoot of the true carps. The peculiar Chinese fish Gobiobola combines characters of a loach and of a gudgeon. Catfishes and characins are both older than the carps and probably have invaded their present ranges (South and Middle America and Africa), from the north, where both have been more or less superseded by the carps.

The cultivation of freshwater fishes in China is extensive. Pond-fish culture apparently originated there about 2000 B.C. This doubtless complicates the range of various species and sometimes causes confusion between artificial forms and natural races. The present-day methods are much the same as those in use hundreds of years ago. The fish commonly cultivated are *Cyprinus carpio*, *Labeo jordoni* and species of Hypophthalmichthys. Almost every freshwater fish, large or small, is utilized for food by the Chinese.

In listing the freshwater fishes of China, brief descriptions have been given of the genera and species, with keys to the species when several occur in a genus. Here and there are interesting field notes and descriptions of fishing methods.

There are numerous text-figures, and the nine coloured plates drawn in the field by Mr. Wang Hao-T'ing are admirable.

The well-known Hilsa is the only Clupeoid included in the work. These fishes are marine, occurring along the coasts, but they ascend the rivers to spawn and may penetrate to waters a thousand miles or farther from the sea. An anchovy *Coilia brachygnathus* plays an important part economically, being caught in vast numbers in special nets at Tiengting, Lake Hunan. Of the numerous carps, *Cyprinus carpio* L. is perhaps of the greatest economic importance.

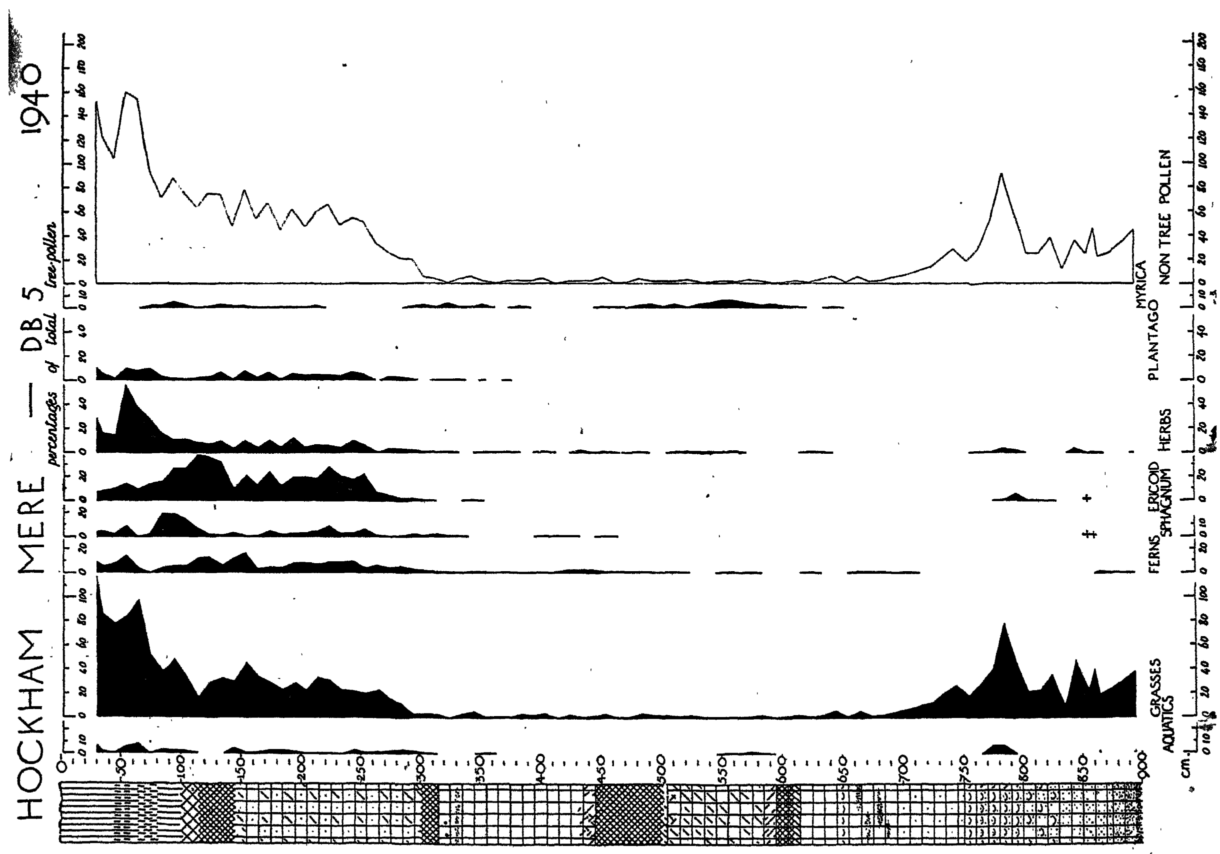
# AGE AND ORIGIN OF THE 'BRECKLAND' HEATHS OF EAST ANGLIA

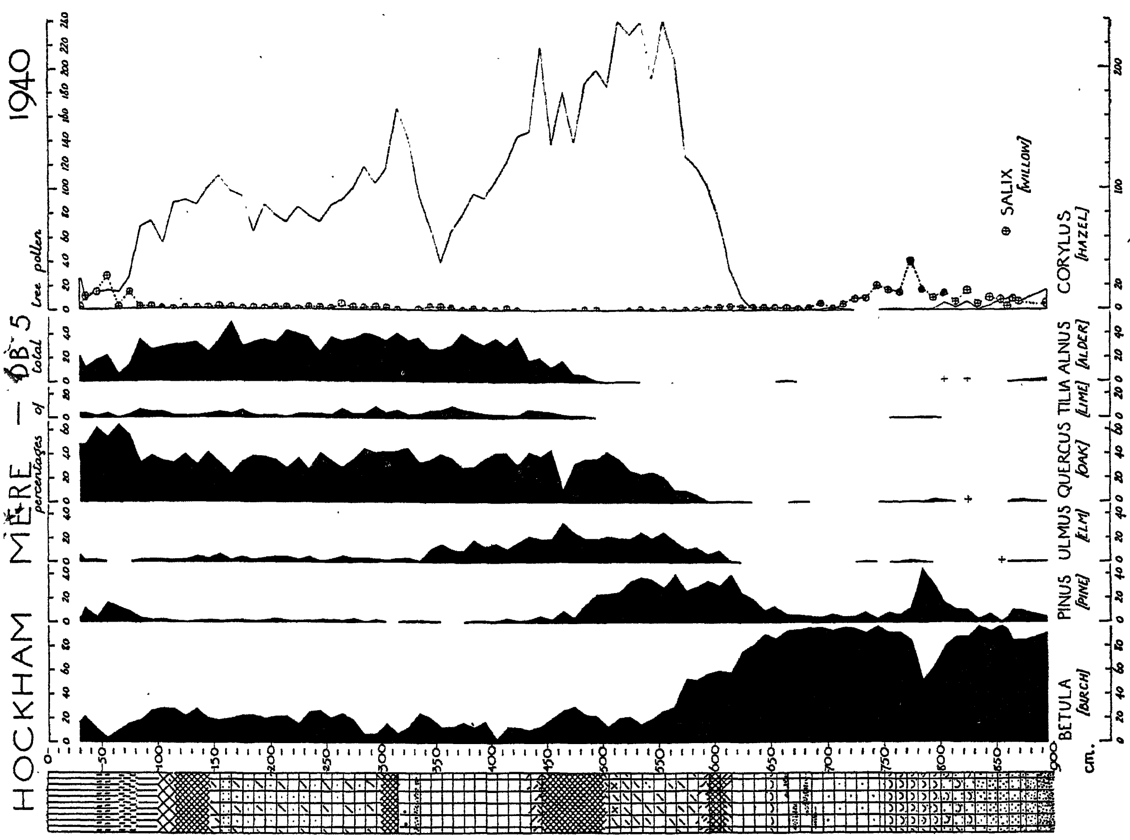
By DR. H. GODWIN
Botany School, Cambridge

IN a recent issue of *Nature*[1] it was pointed out that Iversson had produced evidence from pollen-analysis of lake-muds that, in parts of Denmark colonized by Neolithic man, the continuity and composition of the natural mixed oak forest cover had been much altered by the human introduction of forest clearance by fire. It now seems appropriate to give results which point in a similar direction for the great heath-land area of East Anglia known as the 'Breckland'. The ecological status of the varied plant-communities of grass-heath, sand-sedge, bracken, ling, and sparse woodland has long been in dispute, especially as regards their relation to the factors of climatic, biotic and edaphic (soil) control. It has sometimes been suggested that the rainfall and porous soil may in themselves prevent the development of natural woodland; but others have regarded the heavy grazing, formerly by sheep and now by rabbits, as the only factor preventing recolonization of the heaths by woodland. The basal question has remained unanswered, whether this heathland is determined as such by natural factors, or whether it represents the effect of human interference upon native woodland.

Towards the northern edge of the Breckland is the site of Hockham Mere, which was drained at some unknown post-Tudor date, and the quaking surface of which is now overgrown by wet fen-wood. Borings show that the centre of the lake-basin contains organic lake-muds (nekron-mud or gyttja) to a depth of at least 9 m.: only near the surface are these replaced by the sedge-peats which represent the latest stages of the lake's infilling. Though at the sides the lake-deposits were interrupted, in the lake-centre nekron-mud formed continuously: it is a translucent or rather chalky green jelly with conchoidal fracture, and very rich in pollen. Since such muds form slowly and collect pollen from a wide neighbourhood, it is clear that in the Hockham lake-muds we may expect to find recorded, through the pollen-content, the vegetational history of the northern Breckland throughout a very long period. Moreover, the pollen investigation itself here fulfils a double function. On one hand, the drift of the tree-pollen curves establishes the course of post-glacial forest history, and so allows us to date each stage of the mud accumulation by the correlations already made in Britain between stages of forest-history and archæological, climatic and geological horizons. On the other hand, both tree and non-tree pollen will be direct indexes of the kind of vegetation covering the Breckland hereabouts at each stage of its history.

Events have fortunately realized these possibilities. The tree pollen curves indicate that the oldest muds were formed in a period of birch predominance, where the abundant willow pollen and the high ratio of non-tree to tree pollen indicate the stage of open birch woodland typical of the late-






glacial period. Then follows a relative diminution of the non-tree pollen, and the extension, first of pine and hazel, secondly of elm and oak, and thirdly of lime and alder. The alder-mixed oak forest replaces the birch and pine at a very clear horizon, just as everywhere else in Britain. From this time onwards the tree-pollen curves pursue an uneventful course to the top of the lake deposits, except that we can recognize at 3·3 m. a subsidiary horizon especially indicated by diminution of the elm. This horizon in the Fenland of East Anglia and in the Somerset Levels seems to fall at the opening of the Neolithic period of human culture, and it has been shown to have this correlation also in Denmark and southern Sweden. This correlation is of great importance in the Hockham pollen diagrams, for below this horizon the non-tree pollen of all kinds is negligible; above it there is a sharp increase, and high values of grass-pollen, fern-spores, sphagnum moss spores, ericoid pollen and miscellaneous herb-pollen prevail up to the surface. The nekron-muds continue well above the Early Neolithic horizon, and the stratigraphy makes it clear that this rise in non-tree pollen cannot be due to local changes in the vegetation fringing or filling the lake.

There seems every reason for regarding these high values of non-tree pollens as witness of origin of the Breckland heaths from a pre-existing vegetation of closed mixed oak forest. The high grass-pollen values speak for themselves; the ericoid pollen is indicative of the Calluneta; the fern-spores may or may not have come from bracken communities, for they no longer have their epispores by which fern genera and species can be recognized. The presence of abundant Sphagnum spores is more surprising, but Sphagna persist abundantly in some parts of the Breckland still, and may formerly have been more prevalent. We have not attempted the separate estimation of sedge pollen.

There is no direct evidence of the mechanism by which the vegetational change to heath was brought about; but in view of the conclusions reached by Iversson the correlation of this change with the Neolithic period must be noted, for of course at this time the important flint mines at Grime's Graves were operating, and there is reason to think that there was considerable colonization of Breckland at this time. The suggestion that in a general way the heaths had their origin in Neolithic forest clearance is supported by the recognition that in the Hockham profile, as in Denmark, at the Neolithic level there appears a continuous curve of the pollen of the rib-wort plantain (*Plantago lanceolata*), a species one can only associate with low and relatively open vegetation, and certainly not with woodland cover. It seems likely that with careful diagnosis other equally characteristic species may be identified.

It is pleasing to be able to add in conclusion that Dr. A. S. Watt, speaking from his very extensive knowledge of the ecology of Breckland, sees nothing in this hypothesis of the origin of the Breckland heaths which is not in accord with his own views and experience.

[1] *Nature*, 153, 511 (1944).

# MAGNETISM IN THEORY AND PRACTICE*

By PROF. EDMUND C. STONER, F.R.S.
University of Leeds

THE central theme of this Kelvin Lecture is that general theoretical explanation of the properties of ferromagnetic materials which has become possible only through those fundamental advances in theory, and by experiment, which have been made since Kelvin's time. This theme cannot, therefore, be so directly linked with Kelvin's work as could that of many previous lectures in the series; but the general field of magnetism is one to which he made extensive contributions on both the mathematical and the applied sides. Moreover, there is a characteristic of Kelvin which is particularly relevant. He combined with his interest in abstract theory an equal interest in practical application, and his achievement bears witness to the value of that combination. Such interests are seldom combined in like degree in one person, certainly not accompanied by corresponding powers and knowledge; but much may be done by finding common ground between those whose main interests and points of view are apparently diverse. This lecture is concerned with a common ground where theory and practice in magnetism meet in connexion with the magnetic properties of materials.

Magnetism in practice, that is as applied for directly useful purposes, is almost exclusively concerned with ferromagnetic materials—with iron, cobalt and nickel, with alloys containing one or more of these metals, and with a few compounds. By theory in connexion with magnetism should be understood that general scheme of ideas and principles, built up from and constantly checked by experiment, in terms of which an explanation is sought of even such complicated observable facts as the properties of ferromagnetics. The aim of theory is to explain. To reach even partial understanding may be a not unworthy end in itself. In addition to this, however, theory may serve as a guide to practice. New theoretical knowledge may not immediately benefit old trades; but a stage is always reached, with the development of theoretical understanding, at which the practical man who despises theory is left far behind the wiser but no less practical man who is alive to the possible bearing of theoretical ideas on his own particular problems. This stage is one which is now perhaps being reached in connexion with magnetic materials.

## Magnetization Curves

The most convenient, though not the most logical, approach to ferromagnetism is through the well-known magnetization curves ($B,H$ or $I,H$ curves) for typical ferromagnetic materials. It is sufficient to recall here, first, that a saturation value of the magnetization is closely approached in moderate fields (seldom more than a few hundred oersteds, and often very much less) and, secondly, that in lower fields the magnetic response to a change of field by a given ferromagnetic depends not only on its state of magnetization, or even on the magnetization and the field, but also on how that state has been reached, that is, on the previous magnetic history of the specimen. This means that the same state of magnetization for the material in bulk, as ordinarily measured, may correspond to widely different distributions of magnetization on a microscopic or submicroscopic scale.

If a comparison is made of the $B,H$ curves for two specimens of material of the same composition which have been differently treated, say mild steel as cast and after annealing, an important point is brought out at once. The low-field characteristics (including the initial and maximum permeabilities, and the coercivity) may be widely different, but the saturation magnetization is the same. The saturation magnetization may be described as a primary characteristic of the material; the low-field behaviour depends on secondary effects. Although the details of this low-field behaviour are of paramount importance in most applications, they can be almost ignored in seeking an explanation of the essential property of a ferromagnetic, which is that it becomes magnetized to a high value, characteristic of the material, in what are effectively still quite small fields. It is necessary to discuss this first, because without some idea of how this high magnetization can come about at all, it is impossible to gain a clear understanding of the low-field properties.

## Elementary Magnets and Intrinsic Magnetization

The changes in magnetization of a material in a magnetic field are ultimately due to slight modifications in the motion of electrons induced by the field or to changes in the orientation distribution of elementary carriers of a magnetic moment. The first effect can be neglected in para- and ferromagnetics. The magnetic moment of a carrier is a resultant of the moments due to the orbital motion and to the spin of electrons forming part of the carrier. In most materials containing elementary carriers of a magnetic moment (such as the metallic ions in a paramagnetic salt) the degree of alignment of the elementary magnets, and hence the magnetization, produced by ordinary fields at ordinary temperatures is very small. In fields of, say, 10 oersteds, the magnetization of a paramagnetic is usually less than that of a ferromagnetic by a factor of the order of $10^5$. From the susceptibility of paramagnetics, the magnetic moment of the elementary carriers can easily be calculated, using the results of a simple statistical treatment. The form of the magnetization curves for ferromagnetics suggests, correctly, that the carriers are aligned nearly parallel in relatively small fields. The magnetic moments per atom of the ferromagnetic metals are, however, of the same order of magnitude as those of the ions of paramagnetic salts.

The attainment of a high degree of magnetization in relatively weak fields by ferromagnetics can only mean that there are, in effect, strong forces tending to align the elementary magnets other than those due to the applied magnetic field. If there were no such forces, fields of the order of several million oersteds would be required to produce the observed magnetization. The forces are not simply magnetic forces between the atomic magnets, which are hundreds of times too small. It was suggested by Weiss, in 1907, that there were forces giving rise to what he called a 'molecular field', proportional to the intensity of magnetization. The development of the consequences of this simple formal assumption led to a remarkable co-ordination of a wide range of ferromagnetic pro-

* Abridgement of the thirty-fifth Kelvin Lecture, delivered before the Institution of Electrical Engineers on April 27.

perties; but no explanation could be given then of how such a field could arise.

It may easily be shown that a substance in which there is a positive molecular field in the Weiss sense would be spontaneously magnetized below a critical temperature (to be identified with the Curie temperature), that is, magnetized even in the absence of an applied field; and that the variation with temperature of the spontaneous magnetization would be similar, at least qualitatively, to that observed for the saturation magnetization. The spontaneous magnetization need not, however, be uniform in direction over an ordinary piece of the material. A piece of a ferromagnetic which appears to be unmagnetized must be fully magnetized to the degree appropriate to the temperature; but the direction of magnetization may vary from one part to another of even a single crystal grain. The regions over which the magnetization is unidirectional, containing perhaps many millions of atoms, are usually known as 'domains'. The process of magnetization by an applied field consists essentially in lining up the directions of magnetization of the individual domains, rather than in changing the numerical magnitude of the already existing magnetization. The fields necessary to align the directions of magnetization of the domains are very much smaller than those which would be required to align the elementary magnets in a domain; but these last fields are, in effect, supplied automatically owing to some special type of interaction between the elementary magnets.

Experiments on the gyromagnetic effect show, almost directly, that the elementary magnets in ferromagnetic metals are electron spins, for which there is ample confirmatory evidence. The electrons involved, which belong to specifiable groups in the free atoms, may be regarded as shared in the metal formed by the aggregation of the atoms. The first step in explaining the molecular field effects is due to Heisenberg, who showed, in 1927, that they could arise from quantum mechanical interchange interaction of the same type as is involved in the explanation of the formation of homopolar molecules of the hydrogen type; but whereas in hydrogen the electron spins point in opposite directions and balance each other magnetically, in a ferromagnetic the spins tend to become aligned parallel to each other. It is clear now why the interaction effect should work this way round for only a limited number of metals; and with sufficient strength to produce ferromagnetism in elements—probably only in iron, cobalt and nickel and in some of the rare earth metals. In detail, however, the theory is still far from being quantitatively worked out.

## The Process of Magnetization

Any piece of a ferromagnetic material must be regarded as made up of domains which are themselves magnetized to the saturation value at the particular temperature. The magnetization as ordinarily measured is a resultant, depending on the orientation distribution of the directions of magnetization of the domains, and on their sizes. There are essentially two types of elementary process by which the magnetization can change: first, by a change in the orientation of the direction of magnetization of a domain (without change of size), and secondly, by a 'growth' of a domain at the expense of others with different directions of magnetization (involving a cumulative re-orientation of electron spins at the moving boundary of the domain). Usually the first type of process predominates on the upper part of a magnetization curve, the second on the initial and steep parts.

The factors controlling the direction of magnetization of an individual domain, apart from the applied field and the magnetization of the remainder of the material, are crystal anisotropy, and strain, due either to externally applied, or local internal stresses. The two effects are of the same kind, for a strain may be regarded as a modification of the symmetry of the atomic arrangement characteristic of the undistorted crystal. The extensive complex of relevant experimental material on the magnetization of single crystals, on magnetostriction of single crystal and ordinary polycrystalline material, and on the effects of external stress (particularly tension) on the magnetization curves, has now been successfully reduced to order. For the present purpose it will be sufficient to state that owing to crystal anisotropy and strain, the energy associated with magnetization depends on the direction of magnetization in a definite and determinate manner. For an unstrained crystal of iron (body centred cubic), for example, the energy is lowest for magnetization along any of the six equivalent cube edge directions. As the field is increased from zero with a polycrystalline specimen (or along an arbitrary direction with a single crystal) the domain directions of magnetization first take up, as a result of boundary displacement processes in comparatively small fields, the cube edge directions which are nearest to the field. Further increase of magnetization then occurs more slowly with increase of field, the magnetization 'rotating' from the cube edge towards the field direction; in this process the magneto-crystalline energy increases and the energy in the field decreases, and for each value of the field an equilibrium direction is taken up. If an applied or local stress is sufficiently large, the strain anisotropy may become more important than the natural crystal anisotropy. Under sufficient tension, for example, a material of negative magnetostriction (such as nickel) acquires an 'easy' direction of magnetization at right angles to the direction of tension, one of positive magnetostriction along that direction, and the forms of the magnetization curves are correspondingly modified. In general, in the demagnetized state, each of the domains of a ferromagnetic is magnetized along one of the easy directions determined by the local crystal orientation and the local strain.

Usually a considerable fraction of the total change of magnetization from zero to saturation occurs by boundary movements (equivalent, in effect, to a partial or complete change of orientation of the domain magnetization by a large angle, such as 90° or 180°, from one easy direction to another) in fields smaller than those required to produce appreciable changes by the reversible rotation process. Domain boundaries may be set up where there are local fluctuations of strain favouring different directions of magnetization in contiguous regions. With an applied field increasing from zero a boundary moves in a direction corresponding to an increase in volume of the domain magnetized with the greatest resultant intensity in the field direction. The movement is at first reversible, the boundary taking up an equilibrium position corresponding to minimum energy for each value of the field. Even with a smooth variation with boundary position of the magneto-elastic energy, at a critical value of the field an unstable position may be reached from which a further

finite movement of the boundary takes place spontaneously (that is, without further increase of field) to a new position of equilibrium.

It is owing to these finite spontaneous boundary movements (corresponding to successive reversals, or finite changes of orientation, as the boundary moves, of electron spins over the greater part of the volume of individual domains) that bulk magnetization may change discontinuously, at least on a microscopic scale, as the field changes continuously. This discontinuous character of magnetization is manifested in the Barkhausen effect. A search coil is placed round a ferromagnetic wire, and connected through an amplifier to headphones. On varying the field continuously (say by bringing up a magnet) a rustling is heard. This rustling is effectively a succession of clicks, each click being due to a sudden change of induction over a finite volume of the material, associated with the change of orientation of electron spins. By an elaboration of the experimental arrangements the size of these volumes (effectively domains) may be determined.

The work of Bozorth and others indicates that most of the change of magnetization on the steep parts of the magnetization curve is due to reversals of groups of electron spins over volumes containing not less than $10^{10}$ atoms. The average size of these volumes varies over the hysteresis loop, the maximum for different materials ranging from about $10^{-9}$ to $5 \times 10^{-8}$ cm.$^3$ (roughly $10^{15}$ atoms) for different materials. Owing to this and other work, domains are no longer to be regarded as vague hypothetical entities, but as having accurately determinable physical characteristics.

The peculiar microscopic distribution of magnetization in ferromagnetics arises from the complex interplay of a number of factors. The interchange interaction, or molecular field effect, very powerful over short distances, tends to align the electron spins parallel to each other. The long-range ordinary magnetic forces tend to produce a state of the ferromagnetic specimen in which there are no free poles, a demagnetized state. The compromise is an arrangement in which there is parallel alignment within each domain, and in which the increase of interaction energy due to the non-parallel alignment in the transition zones, or boundaries, is balanced by the decrease in the purely magnetic energy. The details of the arrangement, such as the precise size of the domains and the width of the boundaries, depend very largely on the magnitude and distribution of the internal strains, that is, on a secondary structure which is not peculiar to ferromagnetics.

The details of the internal stress distribution are dependent not only on mechanical and thermal treatment but also on the presence of atoms or groups of atoms which do not fit smoothly into the main lattice, or in other words do not form a solid solution. These may be impurity atoms which it is difficult to remove, and even in minute amounts their effect in decreasing permeability and increasing coercivity and hysteresis loss may be considerable owing to the local strains introduced. Effects which are disadvantageous if the object is the production of material of high permeability may, however, be aimed at deliberately in the production of alloys of high coercivity suitable for permanent magnets.

Quantitative theoretical expressions have been derived for the initial permeability and the coercivity for a variety of assumed distributions of the internal stress. These all indicate that the initial permeability will vary as the square of the saturation magnetization, $I_0$, and inversely as the product of the saturation magnetostriction, $\lambda$, and the mean amplitude, $Z_i$, of the internal stress variations. The numerical factors are different, but of the same order of magnitude, in different special cases. The coercivity varies directly as the product $\lambda Z_i$ and inversely as $I_0$, but the numerical factor varies over a wide range for different types of stress distribution.

For a full account of the theoretical treatment which has been outlined, and to which many have contributed, reference may be made to the book by Becker and Döring published just before the War. The theoretical ideas not only provide a satisfactory qualitative interpretation of, and guide to, the behaviour of ferromagnetics in low fields, but also, as quantitatively developed, have been experimentally verified in a large number of cases in which the conditions are sufficiently simple and well defined. It should be made clear, however, that as yet it is seldom possible to give a fully quantitative interpretation of the details of the behaviour of particular ferromagnetic materials, the internal structure of which may be extremely complex.

## Magnetic Materials

The suitability of magnetic materials for practical application depends on their mechanical and electrical properties, and on their cost, as well as on their purely magnetic properties. It is obviously not possible to consider here even the more extensively used commercial materials in detail. The bearing of the general discussion may, however, be indicated. The materials used fall into three main types: electrical sheet steels, used for large transformers, and rotating machines; alloys having a high permeability in very low fields, used for loading cables, for transformers and for electrical instruments; and permanent magnet materials.

The requirements of high induction in fields of a few oersteds, low magnetic hysteresis, and low eddy current loss for electrical sheet are to a large extent met by the commercial iron silicon alloys with up to about 5 per cent silicon. The theoretical arguments indicate that magnetic hysteresis loss is largely dependent on internal strains. Various factors contribute to the possibility of minimizing these in the silicon steels. The alloys are single phase; the silicon by a chemical action renders oxygen and carbon impurities less harmful; and material of relatively large grain size may be produced, with a reduction in the strains associated with grain boundaries. The electrical resistivity increases rapidly with silicon content, being about four times that of iron for the 4 per cent alloy, while the reduction in the saturation magnetization for this same alloy is only about 10 per cent. Single crystals of the alloy show the same type of anisotropy as pure iron, having easy directions of magnetization along the cube edges; and for some purposes the properties of the polycrystalline sheet material may be improved by a combination of rolling and heat treatment which produces a preferential orientation of the grains.

Most of the commercial high permeability alloys contain iron and nickel as the main components. In the prototype binary alloys in the iron-nickel series the highest initial permeability is developed, by suitable heat treatment, in the alloy with 78·5 per cent nickel. The theoretical treatment indicates that high initial permeability should be attainable with materials of low magnetostriction. It is a striking

fact that the highest value is found near the composition at which the magnetostriction changes through zero from positive to negative, though factors other than low magnetostriction are undoubtedly involved in the full explanation of the facts. Owing to the low maximum induction of the 78·5 permalloy, alloys of higher iron content are sometimes advantageous. There is a wide series of commercial alloys in which other elements are added to the basic iron–nickel alloy, giving improvements, for certain purposes, in mechanical and electrical and also magnetic properties.

In permanent magnet materials a high remanence is required combined with high coercivity, the best single number criterion of the suitability of the material being the maximum value of the product of $B$ and $H$ on the descending part of the hysteresis curve. Of the innumerable materials which might be used for permanent magnets—there were well over seven hundred patent specifications by 1935—reference will be made only to the recent alloys of which the prototype is a ternary iron–nickel–aluminium alloy of approximate composition represented by $Fe_2NiAl$. With alloys of the general class, values of $(BH)_{max.}$ from three to fifteen times as great as for tungsten steel have been obtained. These alloys exist in a single-phase state at high temperatures, but if slowly cooled they form a heterogeneous mixture of two phases (one of which is usually strongly ferromagnetic compared with the other) at low temperatures. If the cooling is very rapid the single-phase state persists and the coercivity is low. It is also low with very slow cooling when there is a complete segregation of the two phases. For intermediate rates—cooling in air is suitable for some of these alloys—only incipient precipitation occurs. It is then that the high coercivity properties are developed.

In a qualitative way this is in agreement with the theoretical treatment of the dependence of coercivity on the distribution of internal strains. But it would be misleading to give the impression that a complete quantitative explanation of the magnetic properties of these alloys has been given in terms of strains. Moreover, the remarkable improvement in the characteristics of some of these permanent magnet materials by a treatment which includes cooling in a magnetic field is not yet satisfactorily explained. It would perhaps be just a little disappointing if even now all the peculiarities of permanent magnet materials could too easily be completely explained when, for those curious in such matters, the permanent magnet has for so long presented an outstanding problem.

## Conclusion

In the last twenty years immense progress has been made in the understanding of the properties of ferromagnetic materials, largely as a consequence of advances in fields apparently remote from useful practical application—in the investigation of the fine structure of spectral lines, for example, and in the development of quantum mechanics. Some of the outstanding, or incompletely solved problems are inevitably of specialized interest, but others are very wide in their bearing. The question, "How is it that some metals are ferromagnetic ?", is a general question about the metallic state. The investigation of the markedly structure-sensitive low-field magnetic properties may throw light on structure-sensitive properties generally, hardness, plasticity and the like, which are little understood but of central importance in the technology of metals and alloys.

It is proper that users and makers of magnetic materials should know something of what is happening inside a ferromagnetic when it is magnetized, something of the interpretative scheme in which wider theoretical ideas are brought to bear on the characteristics of particular materials. The answer to eminently practical questions about the core losses of transformers may involve reference to electron spins and quantum mechanical interchange interaction. For dealing with the general situation which is exemplified, it is often suggested that there should be much closer collaboration between those concerned with practical problems in industry, and those concerned with theoretical ones in universities. This is indeed most desirable, and the possibility of such collaboration would be welcomed from the academic side; but unfortunately the number of those in universities whose normal duties leave them opportunity for really effective collaboration is minute.

Even if the obvious needs of universities in respect of staffing are met in the future, it would seem desirable that many more young men with the necessary ability and interest for approaching particular problems from a wider theoretical point of view should be given opportunity and encouragement for dealing with them in this way in industry, while keeping in close touch with practical needs. In the field which has been surveyed, a wider permeation of practice by theory would undoubtedly be to the advantage of both.

# NEWS and VIEWS

## University of Liverpool: Prof. P. M. Roxby

FROM Bromsgrove School, Prof. P. M. Roxby entered Christchurch, Oxford, took the History Schools, studied geography under Herbertson, and, in 1906, began his life-work at the University of Liverpool which then inaugurated a Department of Geography. The value of his work for civic and international goodwill was recognized by the endowment, for him, of the Rankine chair of geography at Liverpool. He has therefore served the University of Liverpool for thirty-eight years, for twenty-seven of which he has held the chair so devotedly that no offer could move him away, until now, on the eve of his retirement, he has felt the call to a new and arduous task. He has made the promotion of international understanding the main aim of his work, has exerted a lasting influence on the teaching of geography to this end in the universities and schools of England, Egypt and China, in all of which countries his old students carry on his work.

An Albert Kahn fellowship took Prof. Roxby in 1912 around the world, and he began his studies of Chinese life and problems, which he has broadened by subsequent visits that have made him an acknowledged and most sympathetic interpreter of China to the West. Endless societies, summer schools, conferences and committees for the promotion of international

goodwill have had his generous help with counsel and speech regardless of time or trouble. Students from foreign lands, especially perhaps China and Egypt, have been drawn to his school of geography and have found in him, as have all his students, not only a teacher but also a friend. Now Prof. Roxby is to go to Chungking at the invitation of the British Council to be a chief cultural link between China and Britain. He thus crowns a life's work at the University of Liverpool with a high adventure of goodwill.

## Royal Institute of Chemistry : Retirement of Mr. R. B. Pilcher, O.B.E.

THE recent announcement of the approaching retirement of Mr. R. B. Pilcher from the office of registrar and secretary of the Royal Institute of Chemistry will have been received with much regret by all members and friends of the Institute. Mr. Pilcher joined the staff of the Institute as clerk in 1892, was appointed secretary in 1895 and registrar and secretary in 1900, and will thus, on his retirement next year, have completed fifty years service as secretary. To all members Mr. Pilcher's name is inseparable from that of the Institute, and it is to his loyalty, devotion and care that the success of the Institute is largely due. In Mr. Pilcher a sense of the human values is highly developed and his administration of the affairs of the Institute bears the impress of his character and personality. To many chemists he has been a very present help in trouble. As registrar and secretary of the Institute, Mr. Pilcher has become acquainted with, and has gained the esteem of, most of the leading British chemists of the past half-century, and he has, by his gracious manner and personality, established and maintained cordial relations with Government departments and other authorities. Mr. Pilcher has shown much interest in the earlier history of chemistry and has made a large and valuable collection of engravings of alchemists and alchemical apparatus. His lectures on "Alchemists in Art and Literature" and on "A Century of Chemistry : From Boyle to Priestley", published by the Institute, have given pleasure to many. Mr. Pilcher's literary gifts are shown not only in these lectures but also in his book, "The Profession of Chemistry", and in the more important "History of the Institute : 1877–1914". When the time comes, the good wishes of his friends, and they are many, will go with Mr. Pilcher into his retirement.

## Committees on Agricultural Education

THE Minister of Agriculture and Fisheries and the President of the Board of Education have jointly appointed a committee to advise them on all aspects of agricultural education to be provided by local education authorities, and particularly on the educational policy and methods of training to be adopted at farm institutes. The committee, which will be a permanent body, is constituted as follows: Dr. Thomas Loveday, vice-chancellor of the University of Bristol (*chairman*); Mr. F. Barraclough, secretary to the North Riding of Yorkshire Education Committee; Dr. J. Ewing, H.M. inspector of schools; Mrs. F. C. Jenkins, assistant director, Women's Land Army; Mr. C. Bryner Jones, formerly Welsh secretary of the Ministry of Agriculture; Mr. L. R. Missen, director of education for East Suffolk; Mr. A. E. Monks, an organizer of the National Union of Agricultural Workers now serving as labour liaison officer to the Minister; Mr. W. A. Stewart, county agricultural organizer and principal of the Northamptonshire Institute of Agriculture; Dr. G. K. Sutherland, H.M. inspector of schools; Mr. R. A. Ward, chairman of the Development and Education Committee of the National Farmers' Union; Prof. J. A. Scott Watson, Sibthorpian professor of agriculture in the University of Oxford.

The Minister of Agriculture has also appointed a committee to consider the character and extent of the need for higher agricultural education in England and Wales and to make recommendations as to the facilities which should be provided to meet the need. This committee will deal with agricultural education provided by agricultural colleges and university departments of agriculture, and will take over the functions of the Ministry's war-time Committee on Higher Agricultural Education. The committee consists of Dr. Thomas Loveday (*chairman*); Mr. R. Beloe, chief education officer for Surrey; Mr. D. G. Brown, farmer and member of the war-time Committee on Higher Agricultural Education, member of the Agricultural Improvement Council; Mr. George Brown, an agricultural organizer of the Transport and General Workers' Union and member of the Hertfordshire War Agricultural Executive Committee; Dr. Charles Crowther, principal of Harper Adams Agricultural College and acting director of the National Institute of Poultry Husbandry; Sir Frank Engledow, professor of agriculture in the University of Cambridge, member of the Agricultural Research Council; Mr. C. Bryner Jones (also a member of the Joint Committee); Mr. T. Neame, horticulturist, governor of Wye College, member of Kent Agricultural Education Committee; Prof. E. J. Salisbury, director of the Royal Botanic Gardens, Kew, member of the Agricultural Research Council and of the University Grants Committee; Dr. G. K. Sutherland (also a member of the Joint Committee); Miss D. S. Tomkinson, member of the Worcestershire County Council and chairman of the Agricultural Sub-Committee of the National Federation of Women's Institutes; Mr. L. G. Troup, county agricultural organizer for Hampshire and executive officer of the County War Agricultural Executive Committee; Mr. J. Turner, vice-president of the National Farmers' Union.

The secretary of both Committees is Mr. F. L. Wormald, Ministry of Agriculture and Fisheries, Block 4, Bickenhall Mansions, Baker Street, W.1.

## Artificial Insemination of Cattle

THE Minister of Agriculture and Fisheries has recently arranged for a review of the principles on which the development of artificial insemination centres in England and Wales should be planned and controlled. Discussions have taken place with the National Cattle Breeders' Association, the National Farmers' Union and the Milk Marketing Board. It is considered that artificial insemination centres should be controlled and developed as a national service on behalf of the livestock industry and that, with the exception of centres established for experimental purposes, licences for such centres should be granted in future only to organizations controlled and financed by producers, such as the Milk Marketing Board, farmers' co-operative societies and the cattle breed societies. It would be a condition of the licence that the centre would be available to all producers of cattle within the area of operation. A Central Advisory Committee is being appointed to advise the Minister upon the economic aspects of the control

and development of centres and to consider applications for licences to set up such centres. The chairman and eight members are being appointed by the Minister, and four members each by the Milk Marketing Board, the National Farmers' Union, and collectively by the cattle breed societies.

## Therapeutic Trials Committee

VOL. 2, Nos. 3 and 4 of the *British Medical Bulletin* is devoted to certain drugs and their modes of action. Dr. F. H. K. Green, of the administrative staff of the Medical Research Council, describes the work of that Council's Therapeutic Trials Committee. In response to representations by the Association of Chemical Manufacturers, the Medical Research Council organized in 1931 a scheme for the clinical testing of new remedies, and the Therapeutic Trials Committee was set up as a disinterested intermediary between the manufacturers and the medical profession, some medical men having been reluctant to carry out tests at the request of commercial firms. It was agreed that foreign as well as British remedies should be tried out and also the products of academic as well as of commercial laboratories. Manufacturers desiring trials by the Medical Research Council must agree to certain conditions. The composition and nature of the substance to be tested must be fully revealed to the Council; manufacturers must not, without the Council's permission, arrange for other independent trials, and the Council is interested only in new substances which have not been therapeutically tested.

When a substance is to be tested, arrangements are made with clinicians of high standing to make tests, usually at more than one hospital, and the Council reserves the right to decide whether the results, favourable or not, shall be published or revealed only to the manufacturer. If a clinician's results are published, they are published under the clinician's name as a report to the Therapeutic Trials Committee. Since the scheme was organized in 1931, more than forty new substances have been tested clinically. Outstanding examples are the classical papers embodying the results of clinical trials of 'prontosil rubrum', which established the therapeutic possibilities in man of the first sulphonamide drug, which had been discovered in Germany; some of the earliest controlled clinical tests of sulphanilamide; trials of stilbœstrol and other synthetic œstrogenic agents. During the War clinical tests of penicillin have been organized and are still going on, and British-made equivalents of important foreign pharmaceutical products are being tested. The control of infections of wounds and burns is also being studied. Ultimately, says Dr. Green, it is at the bedside that the clinical value of any new remedy is decided; but it is evident that the manufacturer, the medical man and the patient all stand to gain by the excellent work of the Therapeutic Trials Committee.

## The Ray Society

THE Ray Society was constituted at a meeting held on February 2, 1844. The report of the Council for the year 1943, which has just been circulated, states that it had been hoped to mark the centenary year by publishing a record of the Society's history; but the preparation of this had to be postponed until libraries are more accessible and times more favourable. It is regretted that it has not been possible to issue any publications during the year, the lamented death of Prof. W. M. Tattersall having prevented the completion of his volume on the British Mysidacea, which, however, is now being prepared for printing by Mrs. Tattersall. A work by Dr. F. E. Zeuner on "The Pleistocene Period, its Chronology, Climate and Faunal Successions" is now in the hands of the printers. The Society has not hitherto published any works dealing primarily with geology, but the Council considers that the subject-matter of Dr. Zeuner's book is so intimately connected with questions relating to the origin and distribution of the existing fauna and flora that it will be of great interest to many members of the Society. Reference is made to the loss suffered by the Society in the death of Sir David Prain, who had rendered important and long-continued service as a member of Council, as treasurer (1932–37), as a vice-president and as a trustee for the Society's investments. The annual general meeting for the current year having been omitted with the consent of the members, the present officers and Council will continue in office.

## Sensitivity of the Human Eye

DR. SELIG HECHT, professor of biophysics at Columbia University, has recently made a tour of American colleges and universities, during which he has lectured to fifteen different Chapters of the Society of the Sigma Xi. His lecture gave some interesting data, arising from his own researches, on the sensitivity of the eye. Under the most favourable conditions, the smallest amount of light which the human eye can detect is 58–148 quanta, representing an energy of $2–6 \times 10^{-10}$ ergs. This 58–148 quanta is the amount of light falling on the cornea, but only about 10 per cent (5–14 quanta) of this is actually absorbed by the retina; the rest is lost by corneal reflexion (4 per cent), absorption by ocular media (50 per cent) and passing on beyond the retina (36 per cent). In the particular experiments described, this 5–14 quanta were absorbed by an area of retina which contained about five hundred receptor cells (rods). It seems reasonable to suppose, therefore, that each quantum was absorbed by a separate receptor cell. Chemical studies have shown that one quantum of light changes (bleaches) one molecule of visual purple. The conclusion reached is that we can see a light when the energy from it is sufficient to bleach one molecule of visual purple in each of 5–14 separate receptor cells.

## Wood Preservatives and Termite Attacks

IN a recent pamphlet entitled "Effectiveness of Wood Preservatives in Preventing Attack by Termites" (U.S. Dept. of Agriculture. Circ. 683. By T. E. Snyder and J. Zetek. Washington: Gov. Printing Office. 10 cents) the opening paragraphs have a familiar ring to those acquainted with some of the more domestic troubles of early British rule in India and elsewhere in the tropics. "Wood has been classified," says the writer, "in the present global war as a critical structural material. Much of the wood to be utilized for the construction of the large number of necessary barracks and storage depots must be installed in the Tropics. Even in the event of a short War, past experience has shown that structures built to last for only short periods of service must be continued to be used long after the War is over. For the protection of wood from attack considerable research and investigation work

has been carried out for some years by several research organisations in the United States, e.g., Forest Products Laboratory of the U.S. Dept. of Agric.; Chemical Warfare Service of the War Dept.; California Termite Investigations Committee; the Western Union Telegraph Company and others." Various wood preservatives have been experimented with, and the writer of the pamphlet deals with them under three heads. Preservative oils, such as creosotes and combinations in petroleum or tar—especially adapted for penetration of timber to be used in contact with the ground. Water-soluble salts, such as zinc chloride, chromated zinc chloride and several proprietary preservatives, are for use as 'white' or clean pretreatments; they are ordinarily used above ground and the wood can be finished or painted after treatment. Certain toxic chemicals which are nearly colourless, dissolved in light petroleum oils, are adapted for the non-pressure immersion treatment of finished articles. The wood does not swell or shrink, dries rapidly, and is left clean, and after treatment it can be finished or painted. Many methods have now been devised for preserving wood, some simple non-pressure processes, others pressure processes requiring expensive equipment.

## American Philosophical Society

The American Philosophical Society Year Book 1942 covers the year January 1, 1942, to December 31, 1942, and, in addition to the minutes of the meetings and of the executive sessions, includes the reports of standing committees, the report of the Special Committee on Zoology in the Library of the Society, awards of prizes and a list of members. The report of the Committee on the Library refers to the study, in furtherance of the policy of selecting the history of American science and culture as one of the two or three major fields in which the Library should develop its holdings, by a committee of Dr. Conklin, Dr. Moore and the Librarian, of the possibility of building up a really great collection on the history of evolution. The report of the Committee on Research details the general principles adopted in regard to grants, requests for which have been fewer than previously because of the participation of many scientific men in research connected with the war effort. Increased demands are anticipated after the War, and the Committee has recommended accordingly that there should be no reduction in the amount assigned for 1943, but that any unexpended balances in the three funds for 1942 and 1943 should be carried over to be disposed of by the Committee after the War. Lists of grants from the Penrose Fund, the Johnson Fund and the Dorland Fund are included with brief reports from recipients of grants on their work. Obituary notices of members include some which will be of interest to British readers.

## University of Leeds Library

The report of the librarian of the University of Leeds for the session 1942–43 refers to the rapid growth of the Library as shown by the addition of 5,244 volumes during the year, 4,965 of which were added to the Brotherton Library, as well as 2,182 pamphlets and 8,051 periodicals (parts). The total holding of the Library is now 245,839 volumes and 11,007 pamphlets. In the Brotherton Library, 17,476 slips were added to the author catalogue and 2,800 cards to the subject catalogue during the year, figures which are, in all, higher than any previously recorded. Although the inter-lending scheme was originally adopted by the Library Committee with reluctance, it is now generally agreed that the scheme has become of great national importance, and instances are quoted in the report of the lending of publications which proved of inestimable value. No further increase can be coped with in this respect if the staff continues to be depleted without efficient replacement. A thorough overhaul of the medical library has been commenced and extensive purchases made; but the problem of accommodation is more acute than ever. The use of the Holden Library also continues to increase, and when the rare books and series that have been removed from Leeds are returned there will be no more vacant shelf space. In spite of the fact that the rare books and manuscripts of the Brotherton Collection remain in places of safety away from the University, inquiries from outside have increased.

## Repeaters in Submarine Cable Telephony

A paper read in London on May 11 before the Institution of Electrical Engineers by Mr. R. J. Halsay considers the problem of multi-channel carrier telephone working on submarine cables, to the permissible limits of attenuation, in relation to present-day practice, and examines the difficulties thereof. While it will be possible to obtain some small increase in the utilization efficiency of such cables by increasing the transmitted power, reduction of the permissible receiving level below the present limit of about $-110$ db. appears to be impracticable. Development has now reached a stage where the availability of submerged repeaters is essential to further substantial progress, and the design of such repeaters is engaging attention both in Great Britain and in the United States of America. Details of a repeater, laid by the British Post Office in the Irish Sea on June 24, 1943, are given in the paper, and it is believed this repeater is the first to be incorporated in a working cable system. It is suitable for depths down to about 200 fathoms, though at present it is laid in only 35 fathoms. By its use the number of circuits operable over the single cable has been increased from 24 to 48. The further development of repeaters for shallow- and deep-water operation is discussed, the ultimate objective being the provision of considerable numbers of inter-continental telephone circuits over submarine cables.

## Institute of Industrial Administration

The report of the October 1943 conference of the Institute of Industrial Administration has now been issued under the title "Management in Action". It includes papers by W. C. Puckey on "Organising for Production", by E. F. L. Brech on "The Personnel Function", by C. E. Holmstrom on "Marketing the Product", and by A. L. C. Chalk on "Financial Administration", together with Sir Cecil Weir's address "Industry After the War" and the presidential address by Viscount Davidson, and also reports of the discussions. The report emphasizes that the idea underlying all the papers is that management must be, first and last, an instrument of service to the community, and indicates that the Institute is facing the problem of the integration of industry and society as one of the first we must solve if we are to build a post-war social and industrial structure which gives full play to individuality and human values.

## College of the Pharmaceutical Society

THE College of the Pharmaceutical Society of Great Britain has continued in its temporary accommodation in Cardiff, being distributed between University College and the Medical Unit of the Royal Infirmary, with the Pharmacological Laboratories and Department of Nutrition under the direction of Dr. K. H. Coward at the National Institute of Research in Dairying, Reading. The chair of pharmacology, left vacant by the appointment of Prof. J. H. Gaddum to Edinburgh, has not yet been filled. Although the College has lost many of its research workers, who left for some form of national service during 1942–43, it is gratifying to see that a large output of research work is still being maintained, as judged by the "Annual Report of Research Work" covering the period January 1942–June 1943, which has recently been issued.

## Two Czech Chemists

THE Association of Czechoslovak Scientists and Technicians and the Czechoslovak Research Institute, London, have issued a pamphlet with the above title, by Dr. G. Druce (New Europe Publishing Co., 29 St. James's Street, London, S.W.1. Pp. 67. *3s. 6d.*). It describes the life and contributions to science of Prof. Bohuslav Brauner (1855–1935) and the less known Frantisek Wald (1861–1930). An adequate account is given of Brauner's work in inorganic chemistry, which centred around the Periodic Law; and the theoretical views of Wald on stoichiometry and the theory of phases (which were highly rated by Ostwald) are explained in an intelligible way. The work, which has useful bibliographies, is a significant and interesting contribution to the history of chemistry.

## Lady Tata Memorial Trust Awards

THE Trustees of the Lady Tata Memorial Fund announce that, on the recommendation of the Scientific Advisory Committee, they have agreed, if circumstances permit, to make the following awards for research in blood diseases, with special reference to leukæmia, in the academic year beginning on October 1, 1944: grants for research expenses to Prof. L. Doljanski (Jerusalem), Dr. J. Furth (New York), Dr. P. A. Gorer (London), Dr. A. H. T. Robb-Smith (Oxford); part-time personal grant and grant for research expenses to Dr. W. Jacobson (Cambridge).

## University of London

PROF. FRANK HORTON has been re-elected vice-chancellor of the University of London. Recent appointments in the University include the following: Dr. H. B. Acton, lecturer in philosophy at Bedford College, to the University chair of philosophy tenable at Bedford College. Dr. H. T. Flint, reader in physics at King's College, to the Hildred Carlile chair of physics tenable at Bedford College. Dr. W. N. Bailey, lecturer in mathematics in the University of Manchester, to the University chair of mathematics tenable at Bedford College. The title of reader in zoology in the University has been conferred on Mr. G. P. Wells in respect of the post held by him at University College. The degree of D.Sc. has been conferred on E. J. Irons (Queen Mary College), A. G. Quarrell (Imperial College), R. W. Powell and R. H. Common.

The following, among others, have been appointed fellows of King's College: Dr. T. Loveday, vice-chancellor of the University of Bristol; Dr. R. E. Priestley, principal and vice-chancellor of the University of Birmingham; Sir Hector Hetherington, principal and vice-chancellor of the University of Glasgow; and Dr. J. Henderson, sub-dean of the Faculty of Science of the College.

## Summer School in Health Education

IN response to requests from the Ministry of Health and the Board of Education, and in order to reduce the strain on the country's transport system, the Central Council for Health Education has decided not to proceed with its Durham School, and to limit attendance at the London School (August 9–19) to students from London and the Home Counties. Details of the London School may be obtained from the Medical Adviser and Secretary, Central Council for Health Education, Tavistock House, Tavistock Square, London, W.C.1.

## Announcements

DR. H. G. SANDERS, lecturer in agriculture in the University of Cambridge, has been appointed professor of agriculture in the University of Reading, in succession to Prof. R. Rae.

LORD HAILEY has been elected president of the Research Defence Society.

BY authorization of the University Court, the Department of Chemistry in relation to Medicine in the University of Edinburgh, the head of which is Prof. G. F. Marrian, will in future be known as the Department of Biochemistry.

DR. C. J. SMITHELLS has been appointed director of research of the British Aluminium Co., Ltd., and will take up his duties in August next. Dr. Smithells was an original member of the research staff of the General Electric Co., Ltd., which he left in 1938 to become general manager of Lodge Plugs, Ltd. He is the author of several books on metallurgical subjects. Dr. A. G. C. Gwyer, the scientific manager of the British Aluminium Co., will reach the retiring age in October 1945, after thirty-three years' service with the Company. During the intervening period he will remain in a consultative capacity in order to assist Dr. Smithells to become conversant with the many problems arising in the Company's research activities.

THE exhibition "Chemicals in War and Reconstruction" organized by the Association of Scientific Workers, will be on view in the Art Gallery, Huddersfield, during the week July 7–14 between 10 a.m. and 7.30 p.m. It will be opened at 6 p.m. on July 6 by Mr. G. B. Jones, chairman of the Yorkshire Section of the Society of Chemical Industry.

IN connexion with the article "Freedom from Want of Food" in *Nature* of June 17, p. 750, Sir Jack Drummond writes: "I did not say that far more milk is being produced to-day than before the War; I directed attention to the rise in consumption of liquid milk that has occurred since 1939. As shown in a recent Ministry of Food publication: 'Food Consumption Levels in the United States, Canada and the United Kingdom', H.M. Stationery Office, 1944, the consumption of milk products in the United Kingdom, excluding butter, in 1943 was 28 per cent greater than in the years immediately before the war".

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## A Virus Attacking Lettuce and Dandelion

DURING the last three years lettuces have been seen in different parts of Britain suffering from a severe disease, the symptoms suggesting infection with a virus. The cause has now been found to be a virus that is also responsible for the chlorotic rings and spots so commonly seen in dandelion (*Taraxacum officinale*).

Symptoms in lettuce appear 1–2 weeks after infection; the young leaves become bronzed as a result of fine brown necroses that form along the veins and in the interveinal areas. In the glasshouse, this is usually only a primary symptom and is followed by chlorosis, with dwarfing and malformation of the whole plants. In the open, necrosis is the major symptom; whole leaves become black and shrivelled and the plants are worthless. The disease is more severe than the common lettuce mosaic and is readily distinguished from it.

The virus is only transmitted by inoculation if some abrasive, such as carborundum, is incorporated in the inoculum. It has been transmitted by the aphides *Myzus ornatus* Laing and *Myzus pseudosolani* Theob., but not by *Myzus persicæ* Sulz., the vector of lettuce mosaic virus. The behaviour of the insect vectors seems to differ from any previously described. No infections are obtained unless aphides feed for at least three hours on the source of infection, and the number of aphides that become infective increases with increased feeding time. This is characteristic of the viruses called persistent by Watson and Roberts[1], but even after feeding for as long as three days on the source of infection the vectors cease to be infective within an hour.

As the perennial host is likely to be the source of infection for the lettuce crop, the name dandelion yellow mosaic virus is suggested.

B. KASSANIS.

Rothamsted Experimental Station,
Harpenden, Herts.
June 20.

[1] *Proc. Roy. Soc.*, B., **127**, 543 (1939).

## Activation of Pyrethrins by Sesame Oil

IN an article on "Activation of Pyrethrins in Fly-Sprays", David and Bracey[1] state that the test insect used in their work was the mosquito, *Aedes ægypti*, and point out that their findings may not hold for other insects. Nevertheless, the use of the term "fly-sprays" in the title is perhaps unfortunate, for we have found that many of their conclusions drawn from work on Aedes do not hold when the house-fly, *Musca domestica*, is the test insect. As shown below, the substitution of lubricating oil, etc., for sesame oil in fly sprays, or in dual-purpose sprays intended for fly and mosquito control, would be unjustified, since such substances do not increase the toxicity of pyrethrins to flies.

Tests on the house-fly are carried out at the Pest Infestation Laboratory in a glass-fronted wooden chamber of 18 cub. ft. capacity. The insecticide is atomized into the chamber by means of an Aerograph artist's brush Type *AE* supplied with air at 50 cm. free mercury pressure. The flies are reared at 27·5° C. and 55–60 per cent relative humidity, and are kept under these conditions before, during and after test. The flies, four–six days old, are liberated into the chamber before spraying and are exposed to the insecticidal mist for 10 min., after which they are returned to their cage for observation of the percentage kill 24 hr. later. The percentage knock-down is counted during and at the end of the 10-min. exposure period.

Earlier work with seventeen samples of sesame oil of various origins showed that the oils caused markedly different degrees of activation of pyrethrins. One oil (sample *TA*.3) caused a slight reduction in both knock-down and kill when incorporated with pyrethrins. This oil was tested again with three other substances of low volatility with the following results. (All percentage kills are corrected for control deaths.)

| Pyrethrins (% w./v.) | Adjuvant (v./v.) | Av. kill (per cent) |
|---|---|---|
| 0·05 | — | 41·5 |
| 0·05 | 5% sesame oil *TA*.3 | 35·2 |
| 0·05 | 5% oleic acid | 48·2 |
| 0·05 | 5% med. paraffin | 30·6 |
| 0·05 | 5% lubricating oil | 36·2 |

It was concluded that adjuvants of low volatility do not as a general rule increase the toxicity of pyrethrins to house-flies, and that those tested have little or no inherent toxic effect when used at 5 per cent. This experiment gave no significant information upon the rate of knock-down of the flies, so several sprays were tested at a reduced dosage.

| Pyrethrins (% w./v.) | Adjuvant (v./v.) | Av. per cent knock-down at 2 min. | 4 min. | 6 min. | 10 min. |
|---|---|---|---|---|---|
| 0·05 | — | 54·7 | 83·2 | 93·8 | 96·7 |
| 0·05 | 5% sesame oil *TA*.3 | 29·6 | 62·8 | 74·4 | 86·6 |
| 0·05 | 5% sesame oil *TA*.4 | 59·1 | 86·1 | 95·0 | 99·2 |
| 0·05 | 5% med. paraffin | 42·5 | 77·4 | 86·2 | 91·6 |
| 0·05 | 0·05% w./v. sesamin | 60·5 | 87·2 | 95·6 | 99·3 |

Sesame oil *TA*.3 and medicinal paraffin reduced the rate of knock-down. Sesame oil *TA*.4, which in several earlier tests has been shown to cause a marked increase in kill of flies by pyrethrins, produced a small increase in the rate of knock-down, as also did sesamin incorporated at a concentration approximately equivalent to that contained in 5 per cent of *TA*.4. With our method of test using flies, therefore, activation for kill is not dependent upon reduction of the rate of knock-down.

The effect of sesamin on kill is shown by the data below.

| Expt. No. | Pyrethrins (% w./v.) | Adjuvant (v./v.) | Av. kill (per cent) |
|---|---|---|---|
| 72 | 0·05 | 5% sesame oil *TA*.43 | 72·9 |
| 72 | 0·05 | 5% *TA*.43 desesaminized | 53·6 |
| 74 | 0·05 | — | 22·8 |
| 74 | 0·05 | 5% sesame oil *TA*.44 | 48·0 |
| 74 | 0·05 | 5% *TA*.44 desesaminized | 29·7 |
| 73 | 0·05 | — | 36·6 |
| 73 | 0·05 | 0·05% w./v. sesamin | 72·8 |

At the time of these experiments the flies were passing through a period of fluctuating resistance. Nevertheless, the following conclusions are valid because the flies for each experiment were obtained from batches of puparia drawn from randomized popula-

tions. Exp. 72 showed that sesame oil *TA*.43 lost markedly in activating power on removal of the sesamin. The mortality with the desesaminized oil was, however, higher than expected of an oil with no activating power. This result was confirmed in expt. 74, in which 0·05 per cent pyrethrins was included for comparison. Exp. 73 demonstrated clearly the activating effect of sesamin.

Five per cent w./v. of sesame oil *TA*.4 used alone in kerosene has been shown to be insufficiently toxic to flies to account for the increase in kill by pyrethrins observed when *TA*.4 was incorporated in the spray.

From chamber tests on house-flies by the method in use at this laboratory, activation by sesame oil of the toxicity of pyrethrins appears, therefore, to be dependent mainly upon the sesamin content of the oil, and increase in kill is accompanied by a small increase in the rate of knock-down. Medicinal paraffin and sesame oil *TA*.3 reduced both the rate of knock-down and the kill by pyrethrins. With Musca, oleic acid and lubricating oil when mixed with pyrethrins caused little or no increase in kill, in contrast to the data recorded by David and Bracey in their tests on Aedes.

The inactive sample of sesame oil *TA*.3 gave a positive colour reaction for sesamin, and optical measurements indicated a sesamin content of about 0·3 per cent w./v. as against the normal 1 per cent (approx.). We now have, therefore, an oil containing a little sesamin, which reduces slightly the toxicity of pyrethrins to the house-fly, and two samples of desesaminized oils, which give a negative colour reaction for sesamin yet cause a slight increase in the toxicity of pyrethrins. There is no reason to doubt that the constituent of sesame oil chiefly responsible for activation of pyrethrins is sesamin; but it seems that there may also be present a complex of secondary factors which, according to its composition, may increase or decrease the effect of the pyrethrins and/or sesamin in a fly spray.

We wish to acknowledge the co-operation of Mr. B. A. Ellis, Government Laboratory, in this investigation, especially for the provision of samples of sesamin and desesaminized oils.

This note, which is based on work being carried out for the Pest Infestation Research Committee, is published by permission of the Department of Scientific and Industrial Research.

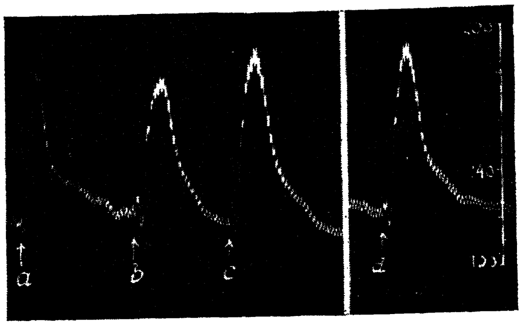
E. A. Parkin.
A. A. Green.

Pest Infestation Laboratory,
Slough, Bucks.
May 22.

[1] *Nature*, 153, 594 (1944).

## Identification of a Urine Base with Nicotine-like Action

In a previous communication, the isolation from urine of a volatile base with nicotine-like action has been announced[1]. The active substance was obtained from normal fresh cow's urine by means of continuous fluid extraction with ether, and isolated as picrate. On the assumption that the active base formed picrate and hydrochloride with one equivalent of acid, the molecular weight was estimated to be 80–90. The active compound showed the reactions of a secondary amine. Microanalysis of the crystalline picrate yielded results which would correspond to the formula $C_5H_{11}N$ for the base.




BLOOD-PRESSURE, CAT, CHLORALOSE. HALF AN HOUR PREVIOUSLY THE ANIMAL HAD RECEIVED 0·1 MGM. ERGOTAMINE TARTRATE PER KGM. *i.v.*

(*a*) 0·05 mgm. nicotine; (*b*) 1 mgm. piperidine hydrochloride; (*c*) 1·5 mgm. of same; (*d*) 1·5 mgm. of urine base hydrochloride.

The nicotine-like effect, which in strength was about $\frac{1}{15}-\frac{1}{20}$ of that of nicotine, and the chemical data obtained, made it probable that the substance was closely related to piperidine. The picrate and hydrochloride of piperidine were accordingly prepared and their action compared with those of the picrate and the hydrochloride of the urine base on the blood-pressure of the cat before and after atropine, on the rabbit's isolated intestine, on the isolated uterus of the cat and on the unanæsthetized frog. In all instances the biological actions of the two sets of substances were, weight for weight, identical. The illustration shows the effect on the blood-pressure of the cat.

The picrate of the urine base melted at 142°, the piperidine picrate at 145° and a mixture of both at 142–143°.

The evidence thus obtained, chemical and physiological, seems to justify the conclusion that the active base is piperidine.

As to the origin of piperidine in urine (up to 10 mgm. per litre) no statements can be made at present. Tentatively, its formation from lysine and pentamethylene diamine should be considered.

U. S. v. Euler.

Physiology Department,
Karolinska Institutet,
Stockholm.
April 8.

[1] Euler, U. S. v., *Acta Physiol. Scand.*, in the Press.
[2] Moore, B., and Row, R., *J. Physiol.*, 22, 273 (1897–98).

## Effect of Unsaturated Fatty Acids upon the Growth of *Lactobacillus helveticus* and other Gram-positive Bacteria

The findings of Bauernfeind *et al.*[1] and of Strong and Carpenter[2] suggest that the accuracy of microbiological assays for riboflavin, with *Lactobacillus helveticus* as the test organism, may be seriously affected by the presence of fatty acids in the extracts under investigation. We have studied the conditions under which such interference may occur using a medium freed from lipids by chloroform extraction. Our results will be reported in detail elsewhere[3].

We find that the growth of an American strain of

*L. helveticus* (from Snell and Strong's original strain No. 7469 and kindly supplied by Dr. Barton-Wright) is almost normal on a medium similar to those of Snell and Strong[4,5] and of Barton-Wright *et al.*[6] but twice extracted with chloroform. Growth has been estimated with varying amounts of riboflavin ranging from 0·05 to 0·5 μgm. per 10 ml. of medium, and with a standardized inoculum and test procedure. The addition of 160 μgm. of caproic or caprylic acid per 10 ml. of extracted medium does not interfere with growth, but similar amounts of palmitic or stearic acid augment it. Oleic acid, however, suppresses growth completely over a period of twenty-four hours, but not for longer. Linoleic and linolenic acids are much more active than oleic acid, inhibiting growth completely for seventy-two hours (the test period we adopt as a routine) and indeed for some days. Half the quantity of linoleic and linolenic acids, that is, 80 μgm. per 10 ml. will almost completely inhibit the growth of our standard inoculum (about 400 million bacteria) for forty-eight hours (linolenic acid more than linoleic acid), and will inhibit the growth of an inoculum of 200 million bacteria for the full seventy-two hours. Sodium salts of these unsaturated fatty acids are equally effective, but their methyl esters are inactive.

The inhibiting action of linoleic acid in a chloroform-extracted medium is reversed in a striking manner by a number of compounds, some of which, like linoleic acid, are surface-active. Thus, in a concentration of 160 μgm. per 10 ml., cholesterol, lecithin, lumisterol, calciferol (but not ergosterol), α-tocopherol, and α-tocopherol acetate completely reverse the action of a similar quantity of linoleic acid. A wide range of other compounds, including fatty acids, vitamins, hormones and carcinogens, does not show any reversing action, but stearic acid, œstrone, sodium fumarate, oxaloacetic acid, maleic acid and dihydroxymaleic acid are weakly active in this respect. The reversing action of cholesterol and of lecithin is found to be equally potent even when the cultures have been inhibited for 48 hours by linoleic acid.

The effects of linoleic acid, so far as we have been able to observe, are reproducible in the case of other Gram-positive bacteria, namely, *Streptococcus agalactiæ*, *Staphylococcus albus*, *Bacillus anthracis*, *Listeria monocytogenes* and *Erysipelothrix rhusiopathiæ*, but not in the case of the Gram-negative *Bacterium coli* and *Proteus vulgaris*. The inhibitory action is marked not only in chloroform-extracted medium, but also in unextracted assay medium and in glucose-broth.

Although a dietary essential, linoleic acid appears to be highly toxic when injected parenterally into mice.

E. KODICEK.
Dunn Nutritional Laboratory,
University of Cambridge, and
Medical Research Council.

ALASTAIR N. WORDEN.
Institute of Animal Pathology,
University of Cambridge.
May 31.

[1] Bauernfeind, J. C., Sotier, A. L., and Boruff, C. S., *Indust. Eng. Chem., Anal. Ed.*, 14, 666 (1942).
[2] Strong, F. M., and Carpenter, L. E., *ibid.*, 14, 909 (1942).
[3] Kodicek, E., and Worden, A. N., *Biochem. J.* (in the Press).
[4] Snell, E. E., and Strong, F. M., *Indust. Eng. Chem., Anal. Ed.*, 11, 346 (1939).
[5] Snell, E. E., and Strong, F. M., Univ. Texas Publication No. 4137 (1941).
[6] Barton-Wright, E. C., and Booth, R. G., *Biochem. J.*, 37, 25 (1943).

## Specificity and Mode of Action of Histamine

WHEN human skin is injured, a substance is released into the tissue spaces which brings about the so-called triple response: a local dilatation of the skin vessels, an increase in their permeability leading to wheal formation, and around this an area of further vasodilatation without notable change in permeability, mediated through a nerve axon reflex. Lewis has shown[1] that when a needle is pricked into the skin through a drop of a dilute solution of a histamine salt, this same triple response occurs, and he therefore suggests that the natural excitant substance ($H$-substance) may also be histamine. We have investigated the chemical specificity of the response in detail by Lewis's simple technique, comparing all results with the negligible effects of control pricks through 0·9 per cent saline.

TABLE 1.

Imidazole-ethylamine (histamine) dihydrochloride $M/10{,}000$ . . . positive

| Group A. Other Imidazoles | | Group B. Other Amines | |
|---|---|---|---|
| 4 (5) Methyl imidazole hydrochloride | $M/4$ | Cadaverine hydrochloride | $M/2$ |
| 4,5 Hydroxy methyl imidazole | $M/10$ | Putrescine hydrochloride | $M/16$ |
| Pilocarpine hydrochloride | $M/2$ | Agmatine sulphate | $M/16$ |
| Imidazole hydrochloride | $M/3$ | Tyramine hydrochloride | $M/21$ |
| | | Arginine hydrochloride | $M/5$ |
| **Group C. Substances of Biochemical Interest** | | **Group D. Injurious substances** | |
| Thiamin hydrochloride | $M/50$ | Sodium dodecyl sulphate | $M/10$ |
| Adenylic acid | $M/100$ | Neutral formaldehyde | $M/5$ |
| Adenyl pyrophosphate | $M/26$ | | |
| Manganese sulphate | $M/2$ | | |
| Hypoxanthine | $M/100$ | | |

Table 1 shows that whereas histamine dihydrochloride itself even in $M/10{,}000$ concentration produces a definite response, the compounds of groups $A$, $B$, and $C$ are all inactive, though in much higher concentration. Those of group $D$ gave weak positive responses in the concentrations stated, presumably by liberating $H$-substance. In other words, the skin reaction appears to be highly specific, in a way similar to the action of histamine on other tissues[2], and this may be taken as additional evidence in favour of the view that histamine and the natural $H$-substance are identical.

Current pharmacological theory[3] holds that many drugs may exert their highly specific effects through the action on specific enzymes in the cell interfering with normal metabolic processes. We have, therefore, tested the effect of histamine on the oxygen uptake and aerobic and anaerobic glycolysis of fresh baker's yeast, which is said to contain no histaminase[4], and which resembles muscle and other mammalian tissues in some of its enzyme systems.

From Table 2 it is seen that histamine acid phos-

TABLE 2. ACTIVE FRESH BAKER'S YEAST, 5 MGM./ML. IN 2 PER CENT GLUCOSE PHOSPHATE BUFFER $p$H 6·5, IN BARCROFT DIFFERENTIAL MANOMETERS CONTAINING 3·3 ML. TOTAL SOLUTION AT 39° C. ANAEROBIC GLYCOLYSIS OBTAINED BY ADDITION OF 0·02 $M$ CYANIDE TO FLASKS, AND SUBTRACTION OF AEROBIC VALUES. EQUILIBRATION FOR 12 MIN. $CO_2$ ABSORBED BY 10 PER CENT KOH PAPERS IN CENTRE TUBES.

| | | | | Plus $M/20$ histamine | | |
|---|---|---|---|---|---|---|
| Min. | Oxygen used | Aerobic $CO_2$ | Anaerobic $CO_2$ | Oxygen used | Aerobic $CO_2$ | Anaerobic $CO_2$ |
| 15 | 70 | nil | 82 | 70 | 10 | 100 |
| 30 | 120 | nil | 165 | 120 | 20 | 200 |
| 45 | 200 | nil | 227 | 202 | 40 | 290 |

All values expressed in c. mm. of gas.

phate in a final concentration even so high as $M/20$ has no significant effect on respiration and produces only a small but unspecific increase of glycolysis in fresh baker's yeast under our conditions.

The succinic dehydrogenase–cytochrome system was also set up, using succinate, pure cytochrome c, and washed minced heart muscle in phosphate buffer $p$H 7·3, kindly prepared by Dr. Hartree. There was no significant difference in the oxygen uptake measured in Barcroft manometers at 39° C. when histamine was added at a final concentration of $M/30$.

It may therefore be concluded that histamine inhibits neither cytochrome oxidase, succinic dehydrogenase, nor any enzyme active in the glucose phosphorylation cycle of anaerobic baker's yeast, and the biochemical mechanism of its specific action remains obscure.

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[1] Lewis, T., "The Blood Vessels of the Human Skin and their Responses" (Shaw, 1927).
[2] Guggenheim, M., "Die biogenen Amine" (Basle: Karger, 1940).
[3] McIlwain, H., *Nature*, 151, 270 (1943).
[4] Zeller, E. A., "Advances in Enzymology", 2, 106 (1942).

## An Androstenetriol in Normal Human Urine

TEN years ago, while working at the University of Toronto, I isolated from human pregnancy urine a new solid alcohol which melted at about 263°. Afterwards, in collaboration with Dr. G. C. Butler, the same substance was isolated in an average yield of about 0·1 mgm. per litre from urine specimens from non-pregnant normal women and normal men, and the following derivatives prepared: an *acetate* (m.p. 189–191°), a *chloracetate* (m.p. 161–163°), a *hydrogenation product* (m.p. 257·5–259°), an *acetate* and a *chloracetate* of the latter (m.p. 174–176° and 180–182° respectively), and a lead *tetra-acetate oxidation product* (m.p. 199–201°). At the time, analyses of these derivatives could not be reconciled with any of the formulæ which the analysis of the parent substance seemed to indicate, and consequently the findings were not published.

More recently, Hirschmann[1] has isolated from the urine of a boy with an adenocarcinoma of the adrenal cortex large amounts of a steroid (m.p. 265–270°) identified as a $\Delta^5$-androstene-3(β),16,17-triol. For the following reasons it is believed that this substance is identical with the one isolated by Dr. Butler and me from normal human urine:

(1) The analyses of the above-mentioned derivatives (but not of the parent substances) are in close agreement with those required by theory; (2) the melting points of the androstenetriol triacetate (187–188·5°), the androstanetriol (256–260°), and the androstanetriol triacetate (175·5–176·5°) as reported by Hirschmann agree closely with those of the corresponding derivatives of the compound from normal urine; and (3) the melting points of the acetate and of the acetate of the hydrogenation product were not depressed by admixture with androstenetriol triacetate and androstanetriol triacetate, specimens of which were very kindly supplied by Dr. Hirschmann.

The original difficulty in reconciling the analyses of the derivatives with those of the parent compound can probably be ascribed to the presence in the latter of solvent of crystallization, since certain of Hirschmann's preparations of the androstenetriol gave analytical figures indicating the presence of half a molecule of methanol of crystallization.

Hirschmann has raised the interesting possibility that this androstenetriol may be produced from dehydro*iso*androsterone by a metabolic process similar to that involved in the conversion of œstrone to œstriol. The finding of this androstenetriol in normal human urine is of considerable interest, since it shows that the metabolic process by which it is formed is a normal one.

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[1] Hirschmann, H., *J. Biol. Chem.*, 150, 363 (1943).

## Identification of Trypanosomes by Chromosomes

FOLLOWING a suggestion by Dr. H. Fairbairn, sleeping sickness officer, Tanganyika Territory, namely, that it might be possible to distinguish *Trypanosoma brucei, gambiense* and *rhodesiense* by the appearance, or the number, of chromosomes in each, the majority of the recognized chromosome-staining techniques were explored. Two methods gave good results, either using dried blood films from rats with very heavy infections, or probes of infective tsetses. The latter is a new method devised by Dr. E. Burtt, entomologist, at the Trypanosomiasis Research Station, Tinde, Tanganyika, in which the fly is caused to salivate upon a glass slide; I have modified the original method, in order to facilitate the handling of large numbers of tsetses. (*a*) The films are fixed with acetic alcohol[1] and stained with Giemsa or hæmatoxylin. (*b*) The films are hydrolysed for 4–6 minutes in normal hydrochloric acid at 60° C. and then stained with Giemsa for 1–2 hours.

It has only been possible so far to examine *Trypanosoma rhodesiense* (Tinde strain) and *T. congolense* (Shinyanga strain). Mitosis occurs in both these species, as has been previously noted by several authors, quoted by Wenyon[2]. The present observations show that *T. rhodesiense* has two types of individuals, one homoploid, with two paired and two unpaired chromosomes ($N = 6$) and the other heteroploid with two paired and one unpaired chromosomes ($N = 5$). *T. congolense* has also been observed to have two types of individuals, one with three paired chromosomes and the other with three paired and one unpaired chromosomes.

It appears, although this is not yet confirmed, that meiosis may also take place, the unpaired chromosomes acting like the sex chromosomes of other animals, and that gametes are thrown out by the meiotic trypanosome. The latter are presumed to unite with the reduced nucleus of another trypanosome, but this has not yet been observed. Fry[3] observed and recorded objects he considered were gametes being extruded from a trypanosome. I have observed similar flagellated objects near the trypanosomes, and others that appear to be in the process of being extruded, in a stained (acetic-alcohol–Giemsa) slide of *T. congolense* from a probe of a laboratory-infected *G. morsitans*.

Work on these lines is being continued, and it is hoped to publish a fuller account elsewhere later.

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[1] Darlington, C. D., and La Cour, L. F., "The Handling of Chromosomes" (London, 1942).
[2] Wenyon, C. M., "Protozoology", 1 (London, 1926).
[3] Fry, W. B., Reports of the Sleeping Sickness Commission of the Royal Society No. XII, p. 25 (1912).

## Electro-magnetic Wave Crystals

AT the conclusion of her very interesting lecture on "Diamonds, Natural and Artificial"[1], recently given at the Royal Institution, Dr. Kathleen Lonsdale mentioned past attempts at producing artificial diamonds by dissolving graphite in a molten metal at a very high temperature and letting the solution solidify under very high pressure. There is, in her judgment, strong evidence that some of the recorded attempts were successful.

I would suggest the possibility of another method of producing artificial diamonds which appears to me worth investigating, particularly in view of the much wider field which it may open.

The essence of this method consists in causing crystallization to proceed in a space filled with stationary electro-magnetic waves with the nodal points corresponding to the positions of the atoms in the crystal. It seems that in this way any feasible atom lattice can be realized, for it can be shown, on the lines which I used for determining stable positions of a rotating electron beam[2], that these nodal points will also be the points of maximum stability of corpuscles. Such an electro-magnetic wave pattern can be called an 'electro-magnetic wave crystal'.

The simplest electro-magnetic wave crystal corresponding to the diamond will be formed by three intersecting sets of plane stationary waves with the nodal planes determined by the sets of directional cosines 100, $\frac{\sqrt{3}}{3}\ \frac{\sqrt{3}}{3}\ \frac{\sqrt{3}}{3}$, and $\frac{\sqrt{3}}{3}\ \frac{\sqrt{3}}{3}\ -\frac{\sqrt{3}}{3}$, and the wave-lengths of travelling waves, propagating in opposite senses and thus forming stationary waves, 1·78 A., 2·06 A. and 2·06 A. respectively. It seems that a diamond could be obtained by solidification of carbon vapour in such an electro-magnetic wave crystal. It may be that this was actually the way in which the natural diamonds were formed, and that their rarity is due to the small probability of spontaneous formation of the corresponding electro-magnetic wave crystals.

It should be possible to extend this method to controlling the formation of any chemical compound by causing an appropriate chemical reaction to take place in an electro-magnetic wave crystal corresponding to the lattice structure formed by the atoms of the compound. For this purpose it would probably not be necessary to form a complete electro-magnetic wave crystal, in which every single atom of the compound should find its corresponding place; it might be sufficient if the crystal were to accommodate the unstable atoms of the molecule and a sufficient number of atoms of the stable part of the molecule to determine the position of the molecule. There are various possible biochemical and even therapeutic implications of this train of ideas.

The stationary electro-magnetic waves forming such crystals can be produced by interference of monochromatic beams of X-rays or by using electron diffraction. The technical difficulties involved in the construction of an apparatus for this purpose do not appear to be unsurmountable.

It is doubtful, however, whether the work of a single investigator could yield sufficient results, within a reasonable time, to provide the requisite stimulus for further progress along these general lines. I do not expect to be able to undertake anything of the kind myself in the near future, and publish the suggestion in the hope that some who have the opportunities and equipment may be inclined to follow it up.

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[1] *Nature*, 153, 669 (1944).
[2] *Sci. J. Roy. Coll. Sci.*, 121 (1931).

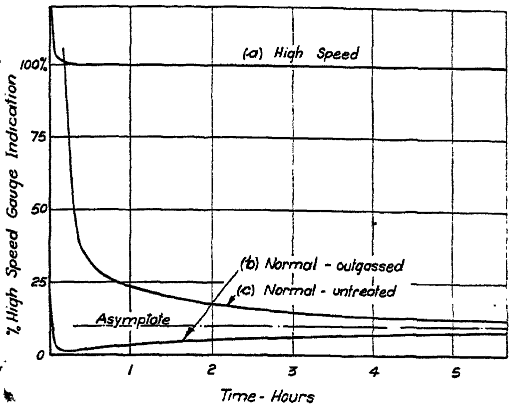
## Use of the Ionization Gauge on Systems Evacuated by Oil Diffusion Pumps

THE ionization gauge is in almost universal use for the measurement of extremely low pressures, and whereas much careful work, for example, Dushman's classical experiments[1], has established its accuracy for permanent gases, very little work which throws any light on the possible sources of error when the gauge is used on systems evacuated by organic vapour pumps has been published.

Some experiments recently carried out in this laboratory have shown that, unless certain precautions are taken, the observed ionization current may be as small as one hundredth of that corresponding to the vapour pressure of the pump fluid. This result was discovered during experiments to determine the errors which would occur if a specially designed ionization gauge were used without degassing, the following procedure being adopted.

Two gauges having identical electrode structures, but with tubulation speeds of 0·7 litres/sec. and 80 litres/sec. respectively, were connected to the same vessel. The vessel, which had a volume of 10 litres and an internal surface area of 5 sq. ft., was evacuated by a standard commercial oil diffusion pump of speed 23 litres/sec. After running this pump for several hours, during which the first (or normal) gauge was ovened and bombarded to remove occluded gases, no treatment whatever being applied to the second (or high-speed) gauge, the two gauges were switched on simultaneously. Readings of the positive ion currents were then taken for a period of six to seven hours. The results of this test are shown by the curves *a* and *b* in the accompanying figure.

It will be seen that the pressure indicated by the high-speed gauge fell to a value within a few per cent of its final value within about five minutes. This is in marked contrast to the very considerable variations shown by the normal gauge, the indication of which first fell to a value just greater than 1 per cent of that for the high-speed gauge, finally increasing asymptotically to about 10 per cent of this value. It would appear logical to ascribe the high indication of the high-speed gauge to the fact that it had not been outgassed, but that this was not the case was




RELATIVE INDICATIONS OF NORMAL AND HIGH-SPEED IONIZATION GAUGES.

easily demonstrated, first by degassing it, when no appreciable change in its final indication was observed; secondly, by running the normal gauge without degassing, its final indication in this case approaching the same asymptote as in the first experiment, in the manner shown by curve c.

An alternative and more tenable explanation of the difference between the indications of the two gauges can be based on the statement of Gaede[2] that the ionization gauge itself acts as a pump and consumes the gas which diffuses into it. For this, among other reasons, Gaede dismissed the ionization gauge as being unsuitable for low-pressure measurements, but there appear to be few references to work where the possibility that gas consumption may vitiate the results has been considered.

Experiments so far carried out here indicate that the consumption of elementary gases and of some of the lighter organic gases such as methane and propane is negligibly small, but that the vapours of some diffusion pump fluids are consumed to a marked extent. Consumption appears to be due to two effects: (a) adsorption or condensation, which is very pronounced when the glasswork is newly outgassed, but which decreases as the concentration of condensate of the surface increases; (b) a consumption effect which does not change as time proceeds, and is probably caused by breakdown of the heavy oil molecules by the hot filament. The former effect, which has also been observed by Hickman[3], accounts for the very low pressure shown early in curve b and for the gradual increase of pressure up to the asymptote. The latter phenomenon was observed by M. R. Andrews[4] in her studies on the reaction between tungsten and naphthalene; but its effect on the accuracy of the ionization gauge has not previously been considered. It accounts for the fact that the asymptotic value of the ionization current for the normal gauge is only 10 per cent of that of the high-speed gauge, irrespective of the time the gauges have been running.

The main conclusion of this communication is that in cases where the vapour of the pump fluid forms a major constituent of the total pressure in a system, special care in the interpretation of ionization gauge measurements is required, and that wherever authors have been unaware of the fact of vapour consumption, the pressures they quote will be proportional not only to the vapour pressure and the ionization constant of the particular pump fluid, but also to the conductance of the tube connecting the gauge to the vacuum system. On the other hand, it will be apparent that by using a gauge which offers no resistance to the entry of gas or vapour from the system, the pressure drop in the connecting tube caused by gas consumption will be reduced to zero, and the third of these variables will thus be eliminated. At the same time, such a gauge (an approximation to which is given by the high-speed gauge used in these experiments) could be used without initial degassing and would be in equilibrium with its surroundings immediately on switching on.

Thanks are due to Dr. A. P. M. Fleming, director and manager of Research and Education Departments, Metropolitan-Vickers Electrical Co., Ltd., for permission to publish this note.

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[1] Dushman, S., *Phys. Rev.*, **17**, 7 (1921); **23**, 734 (1924).
[2] Gaede, W., *Z. tech. Phys.*, **12**, 664 (1934).
[3] Hickman, K. C. D., *J. Frank. Inst.*, **221**, 215 (1936); **221**, 383 (1936).
[4] Andrews, M. R., *J. Phys. Chem.*, **27**, 270 (1923).

## Doppler Effect in Positive Rays of Hydrogen

THE Balmer lines in the spectra of the positive rays of hydrogen show Doppler displacement $d\lambda$ given by the relation

$$\frac{d\lambda}{\lambda} = \frac{v}{c} \cos \theta,$$

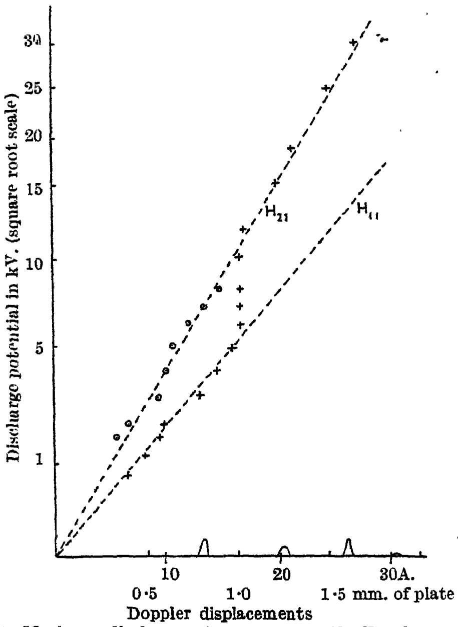
where $\lambda$ is the wave-length of the light emitted by a neutral atom of the positive ray beam, moving with a velocity $v$, the direction of motion of the atom making an angle $\theta$ with the direction of observation; $c$ is the velocity of light.

J. Stark[1], and J. Stark and Steubing[2] showed that whereas the Doppler displacement is not a line but a strip of finite width, the maximum displacement gave a value for $v$ which fell far short of the value to be expected from the relation

$$\tfrac{1}{2} mv^2 = eV,$$

where $e$, $m$ and $v$ are the charge, mass and velocity of the atom respectively, and $V$ is the difference of potential across the electrodes in the discharge tube in which the positive rays were produced. Paschen[3] found that for $V$ varying from 525 volts up to 24,000 volts the maximum Doppler displacement did not show any appreciable increment at higher voltages with increase of voltage. The maximum obtained corresponded to a voltage equal to 5,000. H. Krefft[4] and K. Lion[5] found that the maximum displacement did not remain constant but increased continuously up to 70 kV. and 130 kV. respectively. The values fell short of what is to be expected theoretically. Ney-Valerius[6], who worked at voltages of about 1,000, found values agreeing with the theoretical values.

We have made a systematic investigation, taking special care to see that the maximum values of the Doppler displacement as measured are really the maximum obtainable, and that they are not falsified or minimized for want of adequate exposures on the photographic plates. This has been made possible by taking spectra with varying times of exposures. The maximum so obtained for any one voltage was




+, Maximum displacements measured on the $H_\beta$ plate; ⊙, less displaced maxima; background lines are marked by curves on the abscissa.

found to be constant within wide ranges of the times of exposure.

In the accompanying graph the maximum Doppler displacement actually measured for $H_\beta$ has been plotted against $\sqrt{V}$. Theoretically, all the points should fall on the dotted straight line $H_{11}$. Actually, however, it is seen that the points lie on this line only up to a voltage of 5,500. Between 5,500 and 11,000 volts there is no change in the displacements. The points lie on the straight line $H_{21}$ from 11,000 up to the highest voltage used, namely, 30,000. This line, $H_{21}$, has been drawn theoretically like the line $H_{11}$ with $m$ replaced by $2m$. It follows, therefore, that above 11,000 volts the atom responsible for the maximum Doppler displacement has been derived by dissociation of a molecule of hydrogen accelerated in the discharge tube as a singly charged ion; the dissociation is supposed to take place after leaving the field. Ionized molecules are known to be present from the electromagnetic analysis. The potential 5,500, which corresponds to the value of the maximum Doppler displacement measured in the region of transition from the $H_{11}$ line to the $H_{21}$ line may be regarded as a transition potential.

A relation similar to that with $H_\beta$ has been found by us to hold good for $H_\gamma$ also, between the same limits of voltages. The transition potential for this line, however, is lower, namely, 3,500 volts. The value of the transition potential for $H_\alpha$ may be expected to be higher than that for $H_\beta$. It may, by extrapolation, be taken as about 7,000 volts. On the basis of the theory of ionization by atomic impacts developed by G. Joos and H. Kulenkampff[7], the value of the ionization potential is 6,200 volts. It appears, therefore, as likely that the ionization potential determines the transition potential.

An account of the experimental details and further discussion will be submitted for publication elsewhere; see also the doctorate dissertation, Benares Hindu University, 1938, by one of us (G. K. Das), and the note, by one of us (B. D.) and C. Dakshinamurti, below.

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[1] Stark, J., *Phys. Z.*, **6**, 892 (1905).
[2] Stark, J., and Steubing, W., *Ann. Phys.*, **28**, 974 (1909).
[3] Paschen, F., *Ann. Phys.*, **23**, 247 (1907).
[4] Krefft, H., *Ann. Phys.*, **75**, 75 (1924).
[5] Lion, K., *Z. Phys.*, **83**, 442 (1933).
[6] Ney-Valerius, *Ann. Phys.*, **6**, 727 (1930).
[7] Joos, G., and Kulenkampff, H., *Phys. Z.*, **25**, 1 (1924).

## Ionization Potential and Doppler Effect in Hydrogen Positive Rays

IN the note above by G. K. Das and one of us (B. D.), it has been pointed out that the transition potential as defined therein with positive rays of hydrogen for the $H_\alpha$ line should be about 7,000 volts. We have carried out a systematic investigation with this line, the current being kept constant at all potentials with times of exposure varied within wide limits. The results are shown in Fig. 1.

It may be seen that the transition potential comes

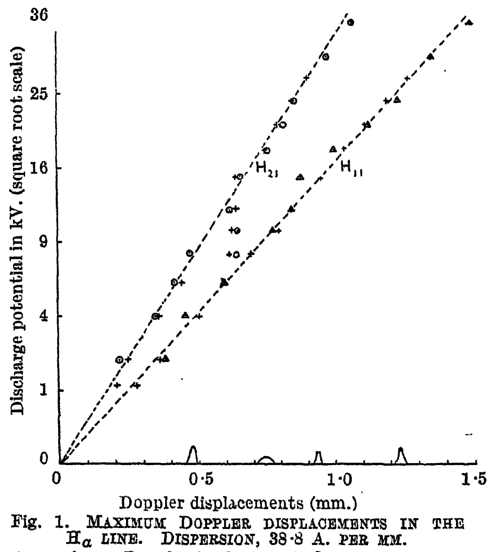


Fig. 1. MAXIMUM DOPPLER DISPLACEMENTS IN THE $H_\alpha$ LINE. DISPERSION, 38·8 A. PER MM.
△, maximum Doppler displacements }graded exposures.
⊙, less displaced maxima
+, exposures of 2 hr. each on a single plate.

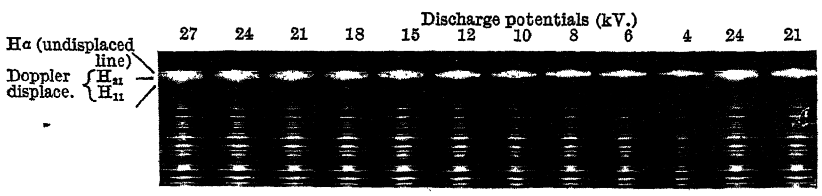


Fig. 2. VARIATION OF DOPPLER DISPLACEMENTS WITH VOLTAGE. NOTE THE INCREASING INTENSITY OF THE $H_{11}$ STRIP AT HIGHER VOLTAGES; TIMES OF EXPOSURE ARE CONSTANT, 2 HR.

out as 7,500 volts. This voltage is in fair agreement with the theoretical value of ionization potential of 6,200 volts on the basis of the theory of ionization with atomic collisions as developed by Joos and Kulenkampff[1], and it is in very good agreement with the values of the ionization potential as directly measured by Bartels[2], namely, 7,000 volts.

The most interesting result in this investigation is the presence of a strip which gives points for the full maximum Doppler displacement falling on the $H_{11}$ line for all the potentials studied, namely, up to 35,000 volts. This strip is faint in the transition region, namely, between 7,500 and 15,000 volts, but becomes increasingly prominent with rise of potential used; see Fig. 2, which is reproduced from a plate on which exposures with different potentials have been taken on the same plate and the time of exposure under each potential used was two hours, in order to be able to estimate the relative intensities independent of time and development. To check that the conditions of experiment have not altered, the first two exposures on the plate were repeated at the end.

Previous investigators were not able to establish agreement between the experimental and theoretical maximum Doppler displacements for potentials above 5,500 volts.

We have carefully investigated the maximum Doppler displacements for the $H_\beta$, $H_\gamma$, $H_\delta$ and $H_\varepsilon$ lines also, in order to be able to understand the outstanding behaviour of $H_\alpha$. A discussion of the same, particularly with reference to measurements carried out by Anna I. Mcpherson with homogeneous beams of positive rays which were made for $H_\beta$ and $H_\gamma$ only, will be reserved for consideration elsewhere; see also doctorate dissertation by one of us (C. D), Benares Hindu University.

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[1] Joos, G., and Kulenkampff, *Phys. Z.*, **25**, 1 (1924).
[2] Bartels, H., *Ann. Phys.*, **13**, 373 (1932).
[3] Mcpherson, Anna I., *Phys. Rev.*, **45**, 485 (1934).

## Roozeboom's Solid Solution Diagram, Type II

Prof. A. N. Campbell, of the University of Manitoba, has suggested[1] that this type of diagram should no longer be mentioned in treatises dealing with the phase rule. A similar opinion is also held by Prof. Jaenecke. I find this conclusion inadmissible for the following reasons.

(1) Roozeboom, in his classical study on the equilibrium of solidification with formation of mixed crystals, asserts this from a purely thermodynamic point of view without reference to the stoichiometric interpretation of the phenomena; consequently, so long as a single example of such a type of equilibrium is known, it is not legitimate to omit a description of it when enumerating possible cases.

(2) Prof. Campbell seems to believe that examples of this type are known only in the case of two pairs of optical antipodes. This is an obvious error. The following examples may be cited: (*a*) Other mixtures of enantiomorphs of which the melting-point curve shows a maximum: secondary butyl hydrogen phthalate[2]; $\alpha$ bromocamphor[3]. (*b*) Other mixtures: 1.2.4.6.tribromtoluene plus 1.2.3.5.tribromtoluene[4]; phenol plus cyclohexanol[5]; bismuth plus thallium[6]; lead plus thallium[7]. None of the maxima in (*b*) corresponds to a simple stoichiometric relationship. (*c*) Finally, if one takes into account the analogous equilibrium between mixed crystals and solvents, Clendinnen and Rivett[8] have described a series of mixed crystals formed by $2NH_4Cl.MnCl_2.2H_2O$ with $MnCl_2.H_2O$ on one hand and $NH_4Cl$ on the other, passing through a minimum of isothermal solubility corresponding to a maximum melting point.

The number of these examples alone shows the necessity of retaining Bakhuis Roozeboom's exposition in its entirety.

(3) Van Laar's demonstration, which Profs. Campbell and Jaenecke mention, does not appear to me to be so very convincing, because van Laar's calculations are based on the introduction of van der Waals' equation (contrary to what Prof. Campbell affirms); in fact, the values of $\alpha$ are calculated with the aid of the terms $a$ and $b$ of the van der Waals' equation as van Laar states expressly on p. 218 of his text.

(4) In order to decide which stoichiometric interpretation to give to such a maximum in the solidification curves, Prof. Jaenecke's considerations do not strike me either as being convincing, though I consider his conclusion as probable. As shown above, the maximum does not always correspond to simple stoichiometric proportions; this fact is almost fatal, as is proved by the outline of the solidification curves themselves, of which the maximum is flattened; consequently, the addition compound existing in the solid phase partially dissociates on melting; and it is quite possible that the addition of one of the products of dissociation to the compound will raise its melting point and thus displace laterally the maximum.

In order to decide in such a case whether one is dealing with a definite compound or a simple hylotropic solution[9], the safest way would be to study the equilibrium of melting under various pressures; if it is a hylotropic solution, the concentration at the observed point will vary continually with pressure, whereas it will remain fixed in the case of a definite compound; this experiment is analogous to the one by which Roscoe and Dittmar proved that the azeotropic mixture $H_2O+HNO_3$ is not a definite compound. But in the present case, in consequence of the slight influence of pressure on the melting point, it is essential to work under pressures varying between limits of several hundred or thousand atmospheres, using, for example, the method of 'piezometric' analysis as perfected by my collaborator L. Deffet and myself[10]. This experiment has not yet been made, but Clendinnen has carried out a similar one by studying the variations of the positions of the minimum of the curve of isothermal solubility at different temperatures, and has proved that in his case it was a hylotropic solution and not a compound.

(5) But in the case of a mixture of optical antipodes such as that discussed by Campbell and Jaenecke, this test fails because the diagram is perfectly symmetrical, from 50 to 0 per cent and from 50 to 100 per cent, owing to the identity of the thermodynamic properties of the two antipodes. It is therefore impossible, strictly speaking, to prove precisely in this particular instance whether the maximum melting point arises from the existence of a definite compound or whether it is a simple hylo-

tropic solution in a diagram perfectly symmetrical at all pressures. But I agree from other considerations that the maximum corresponds there to a definite compound.

*Conclusions:* In a communication which I recently made to the Second Education Conference held by the Association of University Professors and Lecturers of the Allied Countries in Great Britain on April 15, I complained of the fact that in the Anglo-Saxon countries too little use was made of original publications by scientific men on the Continent, with the exception of those from Germany, which appear to be widely read. I should like to emphasize that the foregoing discussion is an excellent case in point.

In my treatise "Les Solutions Concentrées", published in Paris in 1936, in which I gathered together all the known examples of mixtures of two organic components, will be found most of the systems mentioned above. The arguments developed in paragraphs 4 and 5 on the interpretation of the maximum melting point of mixtures of optical antipodes may be found at length in Chapter 4 of another work of mine published in Paris in 1927 and of which an English translation was made by my colleague, Prof. R. E. Oesper of Cincinnati University. This appeared in London and New York in 1940 under the title of "Chemical Species" (see Chapter 4, pp. 18–24).

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1 *Nature*, **154**, 530 (1944).
2 Lombaera, *Bull. Soc. Chem. Belg.*, **33**, 232 (1924).
3 Padoa and Rotondi, *Gaz. Chem. Ital.*, **45**, I, 51 (1915).
4 Jaeger, *Z. Kryst.*, **38**, 583 (1904).
5 Mascarelli and Pestalozza, *Gaz. Chem. Ital.*, **39**, 218 (1909).
6 Kurnakow, *Z. anorg. Chem.*, **88**, 109 (1914).
7 Guertler and Schulze, *Z. phys. Chem.*, **104**, 269 (1923).
8 *J. Chem. Soc.*, **119**, 1329 (1921).
9 See Ostwald, *Trans. Chem. Soc.*, **84**, 106 (1904).
10 *Bull. Soc. Chem. Belg.*, **44**, 44 (1935).

## 'Soil' Mechanics

THE objections raised[1] to the name 'soil mechanics' are timely and cogent, but the difficulty is too deep-rooted to be disposed of by a mere change of the title of the science. The main trouble would appear to be the continued use by engineers of the term 'soil' for material which is not soil in the generally accepted sense, but comprises all soft and loose deposits, namely, gravels, sands, silts, clays and peats. Some workers in soil mechanics also adopt with altered significance other expressions (for example, soil profile) which were first used and are now well established in pedology (soil science).

With the two sciences of soil mechanics and pedology both in a stage of early and rapid development, it is a matter of urgent necessity that steps should be taken to prevent the clashing of terms.

Soil mechanics was christened at the International Congress of Soil Mechanics and Foundation Engineering at Havard in 1936, and appears to have received considerable impetus in Britain after the James Forrest Lecture at the Institution of Civil Engineers by Terzaghi in 1939. Examples could be given from several soil mechanics text-books in which the difficulties of trying to retain a dual usage of the word 'soil' are apparent. In fact, acquaintance with the literature leaves one in no doubt that the adoption of 'soil' to refer to unconsolidated deposits in general has resulted in considerable ambiguity and confusion.

The word 'earth' was in common use in early engineering literature in Great Britain and it is used by some writers on soil mechanics to explain what they mean by 'soil'. It would appear, therefore, to be a more appropriate term and, although not without some objections, it is well established in engineering parlance (for example, earthwork, earth dam, earth pressure). There seem to be few objections to 'earth mechanics' or 'earth statics', provided 'earth' is defined as meaning unconsolidated deposits and excavated material. It is questionable whether engineers would readily accept 'geostatics', and, to the geologist, the prefix suggests something more profound than the surface layers encountered in engineering structures. However, as already stated, the name of the science is not the major issue, which is the misuse of the word 'soil'.

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1 *Nature*, **153**, 716 (1944).

## The Concept of Force

A FINGER pressed against a table has sensations of contact and muscular sensations of resistance. Prof. H. H. Price, in his presidential address to the Aristotelian Society on February 11, analytically supposes the finger to have the muscular sensations only. The owner would have a notion of *force* through these muscular sensations, but no notion of matter because he has no sensations of contact. Thus a being who experiences muscular sensations and never experiences sensations of contact would be "aware of pure force, disembodied force as it were".

When a motor-car turns sharply round a corner the passenger feels as if he were shoved, but not as if a thing shoved him. This centrifugal experience, Price notes, gives the normal human being an experience of "pure force". Also, the supposititious being who has this experience only, because no contact sensations assure him of material things, would fully appreciate the "fields of force" of physics.

The contents of sensory experience are presumably embodied in concepts of *force*, and, however unreflective the embodiment may be, analysis can legitimately expect to disclose it. The talks in the "Hermetica", which were probably finally collected in the third century A.D., are pervaded by a sense of pervasive forces. The talks collect ideas rather than systematize them, and the items in this Greco-Egypto concept of force can be again collected from them into a précis. The forces are efficacious, immortal, imperceptible, unextended, radiative and, though incorporeal, only work in bodies. This concept of force is well compounded; the "radiative", for example, has probably an analogue in solar rays, but the *incorporeal* corresponds to the revelation of "disembodied force" by muscular sensations, and the "only work in bodies" corresponds to the normal connexion between force and material bodies through sensations of contact.

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# RESEARCH ITEMS

### Causes of Death in Fishes in Captivity

A REPORT on the causes of mortality of fishes exhibited in the New York Aquarium at Battery Park, New York City (now closed), is given by Ross F. Nigrelli (*Zoologica*. Scientific Contributions of the New York Zoological Society, 28, Part 4, No. 22; 1943). Careful attention and research have reduced the mortality very considerably in the last few years and all diseases and epidemics are well under control. There are many factors, however, which may cause death besides parasites and disease. Overcrowding is important, sudden change in temperature, the wrong adjustment of light, range and degree of $p$H, density, amount of oxygen, chlorine and nitrogen in the water, metabolic waste products and diet—all cause mortality; also too much handling and too frequent removal from one tank to another. It is established that the fishes themselves contribute largely to their own well-being in fitting themselves to their environment. There is a definite population density of fishes for a given volume of water and the fishes will kill one another off to maintain equilibrium when all other ecological factors are equal. They can, and do, control to a certain degree the chemical contents of their environment. This paper is full of valuable information and should be studied by all who are interested in aquaria.

### Chondrocranium and Visceral Arches of Ascaphus

H. K. PUSEY (*Quart. J. Micro. Sci.*, 84; 1943) has provided an account of the chondrocranium and visceral arches of the frog *Ascaphus truei*, illustrated by seven text-figures and nine plates and containing a comparison with the conditions obtaining in the Urodela and other Anura. G. K. Noble, in a recent classification of the Anura, places Ascaphus with a New Zealand genus Liopelina in a separate family and regards it as the most primitive family of the Anura. The author of the present paper, as the result of his detailed studies, agrees with this, and hence a knowledge of the chondrocranium in this family is essential for an appreciation of the relationships of the higher Anura and of these to the other Amphibia. Ascaphus has more characters in common with the Urodela than the larva of any frog hitherto described, and is in some respects even more primitive than any living Urodele or indeed other living Tetrapod. The most nearly related family of the Anura appears to be the Discoglossidæ. It is not possible within the limits imposed to enumerate all the points brought out, but the consideration of the cartilages and muscles in this form do permit of criticisms of previously proposed interpretations regarding them in Anura and also Stegocephalia. As is only to be expected, Ascaphus possesses certain individual specializations which are clearly indicated.

### Taxonomy of Onchidiidæ

THE family Onchidiidæ has frequently been placed in the Pulmonata, although it has been generally recognized that it has affinities with the Nudibranchs. It has also been regarded as belonging to the Opisthobranchs by other authorities. The recent work of Vera Fretter on *Onchidella celtica* (*J. Mar. Biol. Assoc.*; 1943) has finally provided a solution to this problem and shown that the family is to be regarded as an early offshoot of the Opisthobranchs. In structure the veliger of Onchidella resembles that of the monotocardian prosobranchs, but it lacks a ctenidium and an osphradium. It has a cavity on the right side and, although at this early stage there is no genital aperture, this is to be regarded as a true mantle cavity. During metamorphosis detorsion takes place, and this cavity moves round to the posterior end, carrying with it the anus and kidney opening. At the same time the cavity closes up to become a narrow tubular space and its aperture contracts to a pore. The result of this is that a bilateral symmetry is once again established and the pore at the hinder end of the mollusc, until now regarded as the anus, is, in fact, the opening into the reduced mantle cavity. The metamorphosis is accompanied by a reduction of the visceral hump and the loss of the shell.

### Genes and Cytoplasm

SEVERAL papers recently have reported unsuspected relations between genes and cytoplasm in the production of a phenotypic character. T. M. Sonneborn (*Proc. U.S. Nat. Acad. Sci.*, 29, 329; 1943) describes a remarkable case in *Paramecium aurelia* where a pair of characters, 'killer' and 'sensitive', exhibit this phenomenon. *P. aurelia* individuals carrying 'sensitive' are killed by fluid in which 'killer' individuals have lived. An $F_1$ between killer and sensitive shows that vegetative 'killers' all derive their cytoplasm from 'killer' and 'sensitive' cytoplasm from 'sensitive' parents. Further, a gene $K$ in cytoplasm of race 51 gives 'killer' but not in cytoplasm of race 32. However, if the sensitive gene $k$ is carried in race 51, this race does not develop killer when $K$ is again introduced. Experiments show that the cytoplasm develops a definite substance in the uninterrupted presence of $K$, but $K$ alone cannot produce this killer reaction. Thus 'killer' depends on a gene $K$ and a cytoplasmic substance. This substance is kept in production by $K$, but $K$ alone cannot initiate its production. Sonneborn points out the resemblance of this peculiar behaviour with that in other organisms. For example, cytoplasmic inheritance in plants is closely parallel to results in *P. aurelia*. In this species, however, race 32 contains $k$, which is allelomorphic to $K$. In its presence the cytoplasm ceases to exert its previous influence on the killer character. The antigenic complex of Pneumonococcus may also be compared with *P. aurelia*. Here antigenic types may be transformed into one another by suitable alterations in the environment. It is suggested that a gene of Pneumonococcus will induce the cytoplasm to continue the production of an antigene when the basic substance is already present, but that it cannot initiate this substance. Adaptations may also be of this type, sometimes as in the acquired ability of *Propionibacterium pentasaccarrum* to synthesize vitamin $B_1$ after being supplied with this substance. Mutations may not only be genic or chromosomal in type, but also sometimes may be of this cytoplasmic reaction form.

### Fungus Diseases of Fruit Trees

THREE recent short papers (*J. Pom. and Hort. Sci.*, 20, Nos. 3 and 4; Oct. 1943) describe new diseases of tree fruits. Dr. H. Wormald has isolated the fungus *Cylindrocladium scoparium* from shoots of plum and cherry varieties raised for rootstocks, and has proved its pathogenicity. Fructifications are rarely found on wilted shoots, though microsclerotia are common. Control methods which are suggested

include the dipping of infected stool shoots in Bordeaux mixture. The same author also describes the appearance of papery-bark canker on trees recently top-grafted. The fungus *Stereum purpureum* was isolated from several grafts, but one of them yielded *Polystictus versicolor*. A disease of apple fruits, known as dry eye rot, has been investigated by E. H. Wilkinson. *Botrytis cinerea* is the causal fungus; it attacks through an injured calyx, forms an initial eye rot, remains quiescent for a period, and later involves a complete rot of the whole fruit. Change from a high humidity to drier conditions prevents the progress of the disease to a complete rot.

### Diamonds in the Bolivian Andes

A RECENT discovery of diamonds in the river gravels of the Caupolican district of north-east Bolivia is reported by V. Oppenheim (*Econ. Geol.*, **38**; 1943). The diamonds are associated with gravels derived from Permian tillites. The latter are made up of rocks which are not found in the region but have evidently been transported by Permian ice from the basement metamorphic and igneous rocks of the Brazilian Shield, far to the east. In 1936 the author described the diamond-bearing tillites of the Parana Basin in south-eastern Brazil and showed that the diamonds occurred in acid intrusive rocks such as are thought to be the source-rocks of the diamonds of eastern Brazil. It is suggested that the Bolivian diamonds have probably been derived from a similar source in the Shield, whence they have been transported by ice and concentrated by rivers. Closer investigation is proceeding with the view of ascertaining the possible economic importance of the placer deposits.

### Atmospheric Ozone Determination

E. Glückauf, H. G. Heal, G. R. Martin and F. A. Paneth have described (*J. Chem. Soc.*, 1; 1944) a semi-portable apparatus for the continuous recording of the local concentration of atmospheric ozone. Iodine is liberated by the ozone from sprayed buffered potassium iodide solution and is electrometrically titrated at short intervals with very dilute sodium thiosulphate solution. The small current resulting from the depolarization of a pair of platinum electrodes by the iodine is amplified by a two-stage valve amplifier, and made to actuate an automatic burette containing the thiosulphate solution when the iodine concentration reaches a given value. The whole apparatus is actuated by the A.C. mains.

### Ascorbic Acid as a Photographic Developer

ASCORBIC and *iso*-ascorbic acids have been known as photographic developers since 1934, and formulæ for such developers have been published. Their oxidation products do not interfere with the development process. In presence of a suitable amount of bromide, the two acids yield good image development with only slight fog formation; they show no unusual properties and in general resemble hydroquinone, apart from the lack of activity of the oxidation products. T. H. James (*J. Amer. Chem. Soc.*, **66**, 91; 1944), who has established these results, also finds that the *iso*-acid reacts at a somewhat greater rate. At $pH = 10$ the active developer consists almost entirely of the bivalent ion, which is adsorbed prior to reaction with the silver bromide. In caustic alkali solution, diffusion rates determine the measured development rate. The rate increases with nature and concentration of salts present, the effect being caused by a depression of the double-layer zeta-potential of the silver bromide; this permits greater penetration of bivalent ascorbic acid ions through the double-layer region to the surface of the grain.

### A New Electron-Optical Voltmeter

IN a paper read recently in London before the Institution of Electrical Engineers, Dr. L. Jacob described an electronic instrument for measuring A.C. or D.C. peak voltages in the range of 2–20 kV. to an accuracy of 3 per cent. The voltmeter has a low capacitance (9 cm.) and can be used in some circuits up to frequencies of 1 Mc./s. or more. Its action is based on the proportionality theorem for a triode electron-optical system, in that the angle of the beam is defined by the ratio of two voltages, the anode voltage and the voltage of the modulator grid. The beam angle remains constant when both terms of this ratio are multiplied by the same factor, the modulator bias voltage being directly proportional to the voltage to be measured when the latter is applied to the anode. A high voltage is thus measured in terms of a low voltage, the instrument constituting an electron-optical potentiometer. The range of measurement can be extended as desired. The same principle can also be applied to the construction of high-voltage tubes so that they act as their own voltage-measuring instruments.

### Quantum Mechanics of Fields

THE usual treatment of quantized field theories is not very satisfactory. According to a recent paper by Prof. M. Born and Dr. H. W. Peng (*Proc. Royal Soc. Edin.*, **62**, 40; 1944), the difficulties are somewhat similar to those which occurred in Bohr's semi-classical quantum mechanics of particles. These difficulties were overcome by replacing Fourier series by matrices. In the existing field theories we already have matrices, but we also have indices which do not belong to these matrices, and are related to Fourier series. In short, these theories are still partly classical. The remedy proposed by Born and Peng is to build up a new theory in which each field component is wholly represented by a matrix. The advantages of this are that the technique is much simpler and of the same type as that of ordinary quantum mechanics. The new theory can be applied to non-linear field equations without any mathematical complication, as the superposition principle holds for each state of a pure field. It is hoped to extend the work to account for the production of new particles from the primary ones.

### Trapezium Stars

Otto Struve and John Titus, of Yerkes Observatory, have studied the four stars forming the trapezium in the Orion nebula, and have found that the lines of these stars are displaced more towards the red than the emission lines of the nebula (*Sky and Telescope*, February). It is surprising to find these stars moving with twice the speed of recession of the Orion nebula, because they have usually been thought to be associated with the nebula. Dr. Struve suggests that the stars may shine brightly and yet be of small size but large masses, and that the Einstein effect is in evidence here, as with the companion of Sirius. If this is so, the excess of red shift may not be due to a higher speed of the stars than of the nebula.

# THE ASH TREE

By ALEXANDER L. HOWARD

THE ash stands alone among our forest trees in the peculiar shape and manner of its growth. Sculptors and artists have always been inspired by the grace and beauty of trees and all that the tree bears, so that we have exquisite models of the oak leaf, the acorn, the twisted and gnarled bark of many kinds of trees. The habit and growth of the limbs of the ash being distinctive, the artist has taken it as a model for the arms of the standard and other lights in cathedrals and churches, and the architect for the columns and fair tracery which support the vaulted roof similar to that of the forest glade.

Pliny says:

"There be many trees besides that Nature hath brought forth; for their wood of timber: and among them the Ash, which of all others, groweth most plentiously in every place . . . much ennobled by the praise and commendation that the Poet Homer giveth it, as also for the speare or launce of Achilles, made thereof. . . .

"The Greeks have made 2 kinds of the Ash: the one runneth up tall and even without a knot: the other is lower, more tough and hard, and withall, of a more brown and darkish colour. . . . Others have put a difference between Ashes, according to the places: for that of the plaine and champion country, hath a more curled and fristed graine than the other of the mountaines, but contrariwise, the wood of this is more compact and harder than the other. The leaves of this tree, according to the Greekes, are hurtfull, venomous, and deadly to horses, mules, and such labouring garrons; but otherwise to beasts that chew cud they be harmlesse. . . . Moreover, they be excellent good, and nothing so soveraigne can be found against the poison of serpents . . . nay, so forcible is their virtue, that a serpent dare not come neare the shadow of that tree. . . .

"A wonderful goodnesse of dame Nature that the Ash doth bloome and flourish alwaies before that serpents come abroad."

Yet it would be difficult to trace the original cause of the belief in the supposed efficacy of the cure by what was called the shrew-ash. Superstition has always held an overpowering influence over the mind of man. The medicinal qualities of trees and shrubs were far more generally known and practised in earlier times, when qualified medical aid was difficult to procure, and the health of husband and children devolved far more on the housewife. It is probable that cures which had been effected by the use of the leaves, fruit or juices of the ash trees had actually been brought about, but certain it is that up to a hundred years ago, and even to-day, a belief still prevails in the curative powers of the shrew-ash.

The Rev. C. A. Johns says:

"They have also a superstitious custom of boring a hole in an Ash, and fastening in a shrew mouse; a few strokes with a branch of this tree, is then accounted a sovereign remedy against cramp and lameness in cattle, which are ignorantly supposed to proceed from this harmless animal."

Gilbert White (of Selborne) says:

"In a farm-yard, near the middle of this village, stands at this day a row of pollard-ashes, which, by the seams and long cicatrices down their sides, manifestly show that in former times they have been cleft asunder. These trees when young and flexible, were severed and held open by wedges, while diseased children, stripped naked, were pushed through the apertures, under a persuasion, that by such a process the poor babes would be cured of their infirmity. As soon as the operation was over, the tree in the suffering part was plastered with loam, and carefully swathed up. If the parts coalesced and soldered together, as usually fell out, where the feat was performed with any adroitness at all, the party was cured; but where the cleft continued to gape, the operation, it was supposed, would prove ineffectual. . . . We have several persons now living in the village, who in their childhood were supposed to be healed by this superstitious ceremony, derived down, perhaps, from our Saxon ancestors, who practised it before their conversion to Christianity."

Johns was of the opinion that John Evelyn half believed in the efficacy of this practice.

Many of our well-known arboriculturists have given us accounts of remarkable trees, among which Elwes mentions the Queen Ash at Ashridge Park. He says:

"One of the most perfect examples, from a timber point of view, is a tree growing in a wood called Poultridge, just outside Ashridge Park, which is about 125, perhaps 130 feet high. . . . It had, in 1906, an absolutely straight clean stem, about 75 feet in height by 11 feet 10 inches in girth, and looked as if it would square 27 to 28 inches halfway up, in which case it contains about 400 feet of faultless timber in one length."

The year in which the Conservative Party first occupied the house at Ashridge Park (about 1920) I visited the tree, to find that the measure had increased since Elwes's time. I was informed that an immense price had been offered for it and refused. Alas, within three weeks it was struck by lightning, which revealed that it was almost a hollow shell, with scarcely a sound piece of timber throughout the immense size. It was a strange case, as the tree displayed no sign, appearing perfectly healthy, sound, and clothed with a sound bark throughout. I have repeatedly seen oak trees struck by lightning, ash rarely, elm never; it would be interesting to discover the reason.

No tree repeats itself so vigorously as the ash tree, which through its winged seed spreads far and wide, producing innumerable young seedlings. No tree planted, or transplanted, will grow so sturdily and establish itself so surely. Every gardener finds self-sown ash trees springing up around his beds and paths in such profusion that they become a nuisance, and in those districts where ash plantations abound, every year a wide area of strong naturally regenerated plants will be found. A wiser control in the past would have protected these areas, so that at the least possible cost a wealth of young forest would have been added to our depleted woodlands. This course has never been pursued, and year by year young trees have been trodden down, ploughed up, or destroyed by animals.

While many of the trees grown in Great Britain have been wanted and from time to time have been realizable at varying prices—sometimes actually negligible—the demand for ash has remained constant, and the price regular. Even in Evelyn's time, nearly three hundred years ago, the great value of the ash was recognized. He says:

"In 40 years from the key (seed), an ash hath been sold for £300. sterling, and I have been credibly informed that one person hath planted so much of this one sort of timber in his life-time as hath been valued worth £50,000. to be brought." (£50,000 in his day would be equal to say £100,000 to-day.) "Every prudent Lord of a Manor should employ one acre of ground to Ash with every 20 acres of other land, since in as many years it would be more worth than the land itself."

There can be little doubt that the future will bring the fortunate owner a reward, as it is doing to-day, on a higher scale than any other tree which he could grow.

Of the innumerable species of ash trees which can be found distributed all round the globe, and in pro-

fusion in the United States, Canada, Europe, China and Japan, three kinds only will be referred to in this article—the common ash, the manna ash, and the weeping ash. The common ash (*Fraxinus excelsior*) was abundant in male and female trees before the War of 1914–18, before which time there had been a steady demand year by year; but there was no cause for alarm. With the wholly unexpected and prodigious requirements of the War, and the advent of the aeroplane, whole areas were entirely denuded of the finest trees. A search for straight, well-grown trees, suitable for aeroplane construction, was relentlessly pursued, and ash trees of sufficient length and of clean hard growth brought the owners prices the highest ever known. In the years following the War the demand continued with unabated vigour, and undesirable and unfortunate as it may be deemed, large consignments of trees were sold to Japan.

Through all ages the wood of ash has been used for a great number of purposes, and because of its character it has served a special purpose for which no other wood has been found equal. The early writers or historians continue to record its merits for service both in war and peace.

Johns says:

"As a timber tree the Ash is exceedingly valuable, not only on account of the quickness of its growth, but for the toughness and elasticity of its wood, in which latter quality it surpasses every European tree. In its younger stages (when it is called *ground-ash*), it is much used for walking sticks, hoops, and hop-poles; and it matures its wood at so early an age, that an Ash-pole, three inches in diameter, is as valuable and durable for any purpose to which it can be applied, as the timber of the largest tree. The use of Ash is (next to that of the Oak itself) one of the most universal: it serves the soldier (Spears were anciently made of Myrtle, Cornel and Hazel, but Pliny prefers the Ash for that purpose)—and heretofore the scholar, who made use of the inner bark to write on, before the invention of paper. The carpenter, wheelwright, and cart-wright find it excellent for plows, axle-trees, wheel-rings, and harrows; it makes good oars, blocks for pullies, and sheffs, as seamen name them: for drying herrings no wood is like it, and the bark is good for the tanning of nets; and, like the Elm (for the same property of not being apt to split or scale), is excellent for tenons and mortises; also for the cooper, turner and thatcher; nothing is like it for our garden palisade hedges, hop-yards, poles and spars, handles and stocks for tools, spade-trees, etc. In summer the husbandman cannot be without the Ash for his carts, ladders, and other tackling, from the pike, spear, and bow, to the plow; for of Ash were they formerly made, and therefore reckoned amongst those woods which, after long tension, has a natural spring, and recovers its position, so as in peace and war it is a wood in highest request."

The quality of the wood grown in Great Britain surpasses in its toughness and flexibility that of any other country, although some grown in Canada and some in the Transylvanian Alps approach it very closely. For the purpose for which it is used it would be difficult or even impossible to find a satisfactory substitute. With the advent of the aeroplane, ash became a far more important medium, one indeed on which the whole course of the War of 1914–18 was peculiarly dependent. Ash was used for the longerons, collapsible wheels, internal packing blocks, and for skids and runners for gliders, where length, straightness of grain, absence of imperfections, strength and toughness preserved the lives of flying men. Such was the demand that the whole available existing supply of seasoned wood was exhausted in a few months. Thousands of trees were cut down in Great Britain, and thousands were brought from the Continent. No less than twelve thousand trees could have been seen at one depot, in separate piles. The imported ash produced a longer length of clean straight growth than that grown in Great Britain, showing the advantage gained by scientific forestry practised abroad as compared with the absence of these methods in Great Britain. The largest drying kilns available were continually employed with day and night shifts, year in year out, without cessation, and wood from growing trees was actually in aeroplanes flying over the enemy's lines within a few months of the felling of the trees. Ash was also used for the keel pieces of the gondolas or boats of the blimps or airships. The length required for this purpose was exceptional, being about 26 ft. long, with a dimension of 1¾ in. by 4 in.—a demand which, although drastic, was fulfilled.

The ash tree is attacked by a fungus, the identification of which does not yet appear to have been determined. Everyone will have noticed spreading from the trunk, perhaps at the base, or at any other point to the crown, a collection of overhanging growths, in mushroom form. This is the outward manifestation of the fungus growth in the tree. Sometimes it forms in a part where vigorous young shoots are pushing out, which form what is known as a burr. With the ash tree, however, the fungus mingles with the wood growth, consolidating into one solid mass of apparently woody growth. Such burrs when cut through display the customary bird's-eye surface, but intermingled will be found thin black streaks circling in and out among the bird's-eye marking. Ash burrs, whether pure and white without fungus, or whether as described above, with fungus, have always been highly valued, and for three hundred years used by cabinet-makers in veneer fashion for the making of art furniture. Examples can be found, particularly in the cases of grandfather clocks, especially those made in the reign of Charles I. The fashion would seem to have insensibly fallen away, but has revived again lately.

We must not overlook the weeping ash (*Fraxinus excelsior* var. *pendula*), one of the most decorative forms that any tree bears. This tree appears to have been discovered about one hundred and fifty years ago, and Elwes says:

"Loudon describes several forms of it, and says that the original tree was discovered near Wimpole in Cambridgeshire 150 years or more ago,"

and he refers to another form, "the Cowpen Ash", which he says has "assumed a very similar habit"; and still another, the Kincairney Ash, which "was distinguished by its alternately pendulous and upright branches". He reports a weeping ash, by far the finest known, which was grafted about 1848 at Elvaston Castle, near Derby, and was reported as being 98 ft. high, with long weeping branches, and another with a bole 50 ft. by 12½ ft.

Apparently it is necessary to rear this tree only by means of grafting on to the ordinary common stock, a proceeding which has much been neglected, but which if pursued would give additional interest and much pleasure to those who are concerned with arboriculture. No doubt the enterprising nurseryman will have continued to produce the weeping ash for his customers, but its popularity to-day is insignificant in comparison with about one hundred and forty years ago. The beautiful examples then established can be seen in almost every park and garden, in the gardens of country houses, in the public parks, in cities and the surrounding gardens, and in the botanical gardens,

but the youthful tree which should take its place is conspicuous by its absence to-day.

The manna ash (*Fraxinus ornus*) is another beautiful tree, far too little known or appreciated in Great Britain. It is said to have been introduced by Dr. Uvedale in 1710 from southern Europe. Elwes says the tree was common "in Eastern Spain, Corsica, Sardinia, Italy, Servia, Bosnia, Greece, and Asia Minor".

Later he adds:

"Its chief economic importance is due to its being the source of manna. The manna of commerce, according to Hanbury, is exclusively collected in Sicily . . . incisions are made in the bark . . . and the manna exudes as a clear liquid, which solidifies on the stem of the tree or on pieces of straw or wood that are inserted in the incisions. Manna consists mainly of a peculiar sugar called mannite, which is a mild laxative and is employed as an officinal drug in many countries."

So far as it is possible to ascertain, no use has been made of the manna ash tree for the production of manna in Great Britain, as has been the case in Sicily and southern Europe.

So little is this tree known that the owner of a house had one of them on her lawn, which she highly prized, and which for years was appreciated by those who visited her, but every inquiry she made failed to reveal its identity.

The tree thrives well, and under good conditions will reach a height of 50–60 ft., with a maximum recorded girth of 8 ft. 8 in. A very fine specimen can be seen at Kew, the measurement of which is given by Elwes as 60 ft. high by 7 ft. 6 in. girth. A very fine grove of these trees can be seen near the Castle at Arundel.

A young tree, but already with a beautiful habit, can be seen near the Epstein statue in Hyde Park. This tree, about seven years ago, was heavily loaded with seed, of which I obtained a quantity, and from which I reared three hundred and fifty trees, some of which are now 8 and 9 ft. high. Whether these trees will revert to the original stock or prove to be true manna ash (*F. ornus*) remains to be seen. Generally, if not always, it has been grafted on to a stock of the common ash (*F. excelsior*).

The trunk, with a smooth grey stem, supports the crown, whence branches somewhat drooping bear a rich foliage, not unlike the common ash, but with a more rounded and delicate leaf. Dr. R. Melville says:

"The Manna Ash, . . . exhibits a fair degree of variation in leaf form. There are at least two varieties described of the Manna Ash based upon leaf shape."

The lovely whitish flowers give off a delightful perfume, which permeates the air around the tree.

The wood is of finer grain, but otherwise similar to that of the common ash, but so rarely provided that it is generally unknown to the craftsman.

# CHOLESTEROL METABOLISM IN THE ANIMAL BODY

By Dr. G. A. D. HASLEWOOD

Guy's Hospital Medical School, University of London

THERE has been a considerable amount of recent work on the unsaponifiable fatty material of several types of animal tissue, and one of the results of this kind of experiment has been to throw some light on the changes which probably take place during life in the substance cholesterol (I), a ubiquitous constituent of animal cells.

By no means the least interesting aspect of this research is the somewhat unexpected discovery that the changes undergone by cholesterol are so easily brought about that it is often impossible to say with certainty that they might not have occurred during the processes leading to the isolation of the resulting products from the tissue extract. Moreover, Bergström and Wintersteiner[1] have shown that purified cholesterol itself can be transformed under conditions of *p*H, oxygenation and temperature which must occur *in vivo*. The possibility that enzymic systems might alter the course of cholesterol transformation has not yet been adequately explored, but it seems safe to assume a high degree of probability for the occurrence of at least the following substances in the tissues named, if these are supplied with oxygen at a normal mammalian *p*H and temperature:

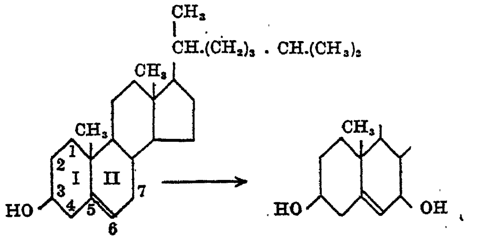
| Substance | Found in extracts of |
|---|---|
| $\alpha$-7-hydroxycholesterol (II*a*) | ox liver[2], pigs' liver[3], mares' serum[4], pigs' spleen[5]. |
| $\beta$-7-hydroxycholesterol (II*b*) | mares' serum[4], human atheromatous aortas[6]. |
| 7-ketocholesterol (III) | bulls' testis[5]. |
| $\Delta^{3,5}$-7-ketocholestadiene (IV) | pigs' testis[7], pigs' spleen[5], human atheromatous aortas[6]. |
| $\Delta^{4,6}$-3-ketocholestadiene (V) | pigs' spleen[5], human atheromatous aortas[6]. |
| 3($\beta$),5,6(*trans*),-trihydroxycholestane (VI) | ox liver[8], pigs' testis[7], human atheromatous aortas[6]. |
| $\Delta^{4}$-3($\beta$),6,-dihydroxycholestene (VII) | pigs' spleen[5]. |
| 3($\beta$)-hydroxy-6-ketocholestane (VIII) | pigs' spleen[5]. |

Substance (IV) is easily formed in mild conditions by dehydration of (III), and may thus arise during the working-up of extracts. Compounds (II*a*), (III), (IV) and a simple transformation-product of (II*b*) have also been found after 'autoxidation' of cholesterol *in vitro*[1], while (II*a*) and (VII) are obtained when cholesterol is subjected to photo-oxidation[9]. It will be noticed that the transformations indicated by the above substances affect only rings I and II of the sterol nucleus; and in fact no evidence has yet been accumulated which would indicate the course of any more profound breakdown of the molecule. Apart from indirect experiments, such as those of Bloch and Rittenberg with deuterium[10], definite proof of further chemical changes during cholesterol metabolism is still lacking.

It may also be noted that, in spite of the facile *in vitro* production of 7-dehydrocholesterol (IX, provitamin $D_3$), from $\alpha$-7-hydroxycholesterol (II*a*), the mechanism of the formation of this important substance in the animal body remains entirely obscure.

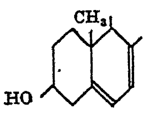
Prelog, Ruzicka and Stein[5] point out that tissues which so far they and their colleagues have examined in great detail differ from adrenal tissues, testis and urine in containing no steroids of the $C_{21}$ (progesterone, corticosterone, etc.) or $C_{19}$ (androsterone, testosterone, etc.) types, a fact which, if it is generally confirmed for other tissues, may prove highly significant for studies of steroid metabolism.

Cholestenone (X) has been found in dogs' and rats' fæces[11] and in pigs' testis[5]. Rosenheim and Webster[11] continue to believe that it is a precursor of fæcal coprosterol (XI), which they think is unlikely to arise, as was formerly believed, by bacterial action in the intestine[12]. The same workers have observed a quite remarkable dietary influence on the production of coprosterol by the intact animal[13]; this discovery may be a valuable lead towards the solution of more than one problem. In this connexion,

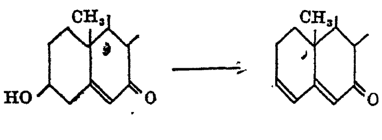


I

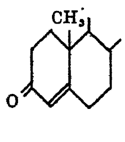
IIa and IIb ($C_7$ epimers)



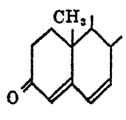
IX



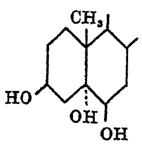
III IV



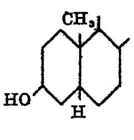
X



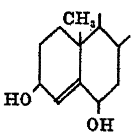
V



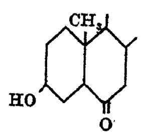
VI



XI



VII



VIII

it is to be hoped that the saturated sterols so frequently stated to be present in tissues will be re-investigated, especially with regard to their complete chemical identification, since it certainly cannot be stated with confidence that coprosterol itself is absent from the body cells.

Since the above substances (II–VIII) are such as may arise in normal cells during life, it would appear reasonable that they should be tested for physiological activity, especially of the kind which may be directly associated with growth processes.

[1] Bergström, S., and Wintersteiner, O., *J. Biol. Chem.*, **141**, 597 (1941); **143**, 503 (1942); **145**, 309, 327 (1942).
[2] Haslewood, G. A. D., *Biochem. J.*, **33**, 709 (1939).
[3] MacPhillamy, H. B., *J. Amer. Chem. Soc.*, **62**, 3518 (1940).
[4] Wintersteiner, O., and Ritzmann, J. R., *J. Biol. Chem.*, **136**, 697 (1940).
[5] Prelog, V., Ruzicka, L., and Stein, P., *Helv. chim. Acta*, **26**, 2222 (1943).
[6] Hardegger, E., Ruzicka, L., and Tagmann, E., *Helv. Chim. Acta*, **26**, 2205 (1943).
[7] Ruzicka, L., and Prelog, V., *Helv. Chim. Acta*, **26**, 975 (1943).
[8] Haslewood, G. A. D., *Biochem. J.*, **35**, 708 (1941).
[9] Windaus, A., Bursian, K., and Riemann, U., *Z. physiol. Chem.*, **271**, 177 (1941).
[10] Bloch, K., and Rittenberg, D., *J. Biol. Chem.*, **145**, 625 (1942); **149**, 505, 511 (1943).
[11] Rosenheim, O., and Webster, T. A., *Biochem. J.*, **37**, 513 (1943).
[12] Rosenheim, O., and Webster, T. A., *Biochem. J.*, **37**, 580 (1943).
[13] Rosenheim, O., and Webster, T. A., *Biochem. J.*, **35**, 920 (1941).

# OBJECTIVE CLINICAL METHODS

A NEW and remarkably ingenious example of the objective clinical methods which are constantly being developed in modern medicine and surgery is the phono-electrocardioscope designed by Dr. G. E. Donovan (*The Lancet*, 500, April 15, 1944), which permits simultaneous direct visual recording of the phonocardiogram, electrocardiogram and sphygmogram, with amplified auscultation through a binaural stethoscope; in addition, photographic records can be made. The expense of such instruments and the difficulty of producing them in sufficient numbers will prevent all but a few workers from using them, but it is worth remembering that some of them can be applied to the study of the normal animal as well as to the sick animal for whose relief they were invented. The electrocardiograph and the techniques of radiography, cystoscopy and duodenal intubation are examples of objective clinical techniques which can be, and are being, used by anatomists and biologists for studies which have no connexion with disease. The cystoscope or the ophthalmoscope, for example, need not always be used for the study of the bladder or the eye. The principle on which such instruments are constructed can be applied to other things. If an instrument allows you to look into the bladder of a man, it may be used also for seeking out the death watch beetle underneath a floor, and it is being used in this way by Prof. Bayley Butler in Dublin; and the biologist, the medical man and the veterinarian can all use modern methods of studying the fluids and soft tissues of the body and so demonstrate that they are all students in the same field of inquiry.

There will always be, however, an especially close correlation between the methods of the medical man and the veterinarian, because it is their common object to understand and to treat disease—or better, to prevent its occurrence and to maintain health. The trend of medical thought is, or should be, as Prof. J. A. Ryle and other medical men have pointed out (see *Nature*, **153**, 443; 1944), to teach medical students to rely less upon instruments and laboratory procedures and more upon the art of clinical observation and inference in which their grandfathers were so skilled. There will, however, always be some aspects of disease which require the instrument and the laboratory expert. You may be able to diagnose malaria or amœbic dysentery with adequate accuracy by experienced interpretation of the symptoms only, but a protozoologist can do it much more quickly and with absolute certainty; in certain cases, indeed, his laboratory report may be the only means of doing it or of saving the patient's life. In the same way, radiography or the electrocardiograph may give vital information which could not be got in any other way.

The value of such objective methods of study can perhaps be most clearly demonstrated when they are applied to patients who cannot tell the medical man or the veterinarian what their sufferings are. The deaf and dumb adult, the infant and the young child who cannot speak—or, if he can, cannot make reliable statements about himself—must tax to the full the art of the clinician who has only his own experience to guide him. Very often such patients require the aid of objective studies by means of instruments or laboratory procedures which cannot, so the optimist at any rate believes, tell a lie. The neurotic or hysterical adult may also require this

kind of study; and there are some diseases, such as trichiniasis, which are so protean in their manifestations and simulate so many other diseases that the diagnosis can only be made by the finding of the parasite or by serological methods which depend upon considerable laboratory experience. The veterinarian, of course, is always confronted by this kind of difficulty; his patients may be able to utter cries the quality of which may tell the experienced hearer of the vital things, but they cannot tell the whole story, and the experience necessary to interpret them comes only after years of practice. It comes, moreover, only to those who have the ability to acquire it; and it cannot be communicated to students and others except by a similar long experience based on a similar ability.

In a matter like this, the veterinarian and the medical man must therefore find a wide field of mutual interest. It is a field which deserves energetic co-operation and exploration. If the children's doctor may seem to be most likely to profit from such co-operation, the whole of medicine may learn much from the study of animal illness. Comparative medicine, whether it be practised by the medical man or the veterinarian, must certainly have a direct interest in objective methods of study which can give it reliable information about the conditions of certain organs, or about such cardinal symptoms as the quality, intensity and distribution of pain, about normal and pathological variations in body temperature, about fatigue, the reactions of the autonomic nervous system and so on. Much might be learnt, too, from a comparative study of the reactions to certain cardinal symptoms of disease which are shown by animals so different as the carnivore, the ungulate, the mammal and the bird.

The interpretation of the results of studies such as these will not be easy. They will usually involve behaviour patterns for the study of which the co-operation of a psychologist will be required. Perhaps we could begin with a reconsideration of the whole basis of Pavlov's work, or at least with a critical examination of certain criticisms of it (see *British Medical Journal*, 487, Oct. 16, 1943; *ibid.*, 305, Aug. 14, 1943; and *ibid.*, 573, April 22, 1944), which would seem to merit the serious attention of biologists. At any rate, we should have to begin with carefully thought out basic experiments, planned by a medical man, a veterinarian and a psychologist, which would be designed to provide a basis for further work. Such a plan has, in fact, been formulated by the Institute of Animal Behaviour, a committee of which is designing a programme of work the object of which is to explore the possibility of creating an objective science of clinical study. A similar theme was discussed at a recent meeting of the Section of Comparative Medicine of the Royal Society of Medicine. There exists, of course, a great deal of knowledge based on objective experiment which will help such a project; and both the medical man and the veterinarian can supply a vast store of clinical experience which will, if it can be systematized, be invaluable. Meanwhile the explorers stand upon their peak in Darien. Let us wish success to their campaign on behalf of all those, whether they be human or animal, who suffer but cannot tell their sufferings, or, if they would tell, are prevented by their own constitutions or immaturities from telling the truth or directing attention to the root causes of their troubles.

G. LAPAGE.

## THE IMPERIAL CANCER RESEARCH FUND

THE Imperial Cancer Research Fund, which has just issued its forty-first annual report, is still carrying out experimental work and is also improving its financial position. During the past year, more than £20,000 has been added to the capital account, so that the Fund has now almost £430,000 in hand and spends about £15,000 a year in supporting research work in its laboratories at Mill Hill.

With a scientific staff of seven and four visiting workers, the laboratories are working in many fields of cancer research. The visitors include Sir John Ledingham, Dr. L. Dmochowski from Poland and Dr. E. Vasquez-Lopez from Madrid. The report of the director, Dr. W. E. Gye, is divided into sections on carcinogenesis, tissue culture, the mammary tumour inciter, and chemotherapy.

The work on carcinogenesis consists of Mr. H. G. Crabtree's study of the effects on the induction of cancer in mice of substances which inhibit metabolic processes. He has found that organic halogen compounds which react with substances containing sulphur in the body are able to retard the induction of tumours on the skin of mice painted with a carcinogen. The halogen compounds are of two types: those in which the halogen is reactive, as in chloroacetone, and combines directly with sulphydryl groups, and others, such as bromobenzene, which react with sulphur compounds in the body without loss of halogen. Both types of compound appear to cause a local fall in concentration of glutathione when applied to the skin of mice. A similar effect was looked for with maleic anhydride, as it is known that maleic acid combines with glutathione. Maleic anhydride applied to the skin of mice treated with benzpyrene proved to be a more potent inhibitor of carcinogenesis than is bromobenzene. The work suggests that sulphur compounds are connected with the induction of tumours in some way which is not yet clear.

If connective tissue cells are grown in tissue culture in contact with carcinoma cells, the growth of the former is stimulated. On the other hand, sarcoma cells tend to restrain the growth of connective tissue. Stimulating effects of carcinomata have long been known to operate *in vivo*, as the change of connective tissue cells into malignant cells in the presence of transplanted mammary tumours has often been observed. Dr. R. J. Ludford and Miss H. Barlow have tried to demonstrate such a malignant transformation in connective tissue cells grown *in vitro* in contact with mammary cancer tissue, but so far without success.

The effect of the mammary tumour inciter, discovered in the Roscoe B. Jackson Memorial Laboratory in the United States, which is present in the milk of strains of mice with a high incidence of breast cancer, has now been shown to operate in the high-cancer strain *RIII* and the low-cancer strain *S*. It is pointed out that the fact that œstrone treatment induces tumours in male mice of susceptible strains indicates that the factor is present in the tissues as well as in the milk of mice in which mammary cancer occurs. The presence of the inciter in spleen tissue has been confirmed.

The difficulties of work on chemotherapy of cancer are discussed. For effective therapy either all the cancer cells must be destroyed, or the stimulus to divide which is present in these cells must be neutral-

ized. Other difficulties are the similarity in properties of normal and cancer cells, and the variation in growth and lethal effects of spontaneous tumours. The advantages of using a tumour which has arisen in a pure line of mice and is transplanted into mice of the same strain are stressed; no reference is made to a tumour of that nature introduced by Dr. E. Boyland some years ago.

# RESEARCH WORK FOR 1944 IN THE ACADEMY OF SCIENCES OF U.S.S.R.

By LYDIA BACH

THE Academy of Sciences of the U.S.S.R., as the guiding centre for all scientific activity in the Soviet Union, has planned its work for 1944 in four main divisions. First, the study of scientific problems of various branches of knowledge for the advancement of science in general; secondly, research work in the sphere of improving armaments for the Red Army; thirdly, the mobilization of resources to strengthen the defence of the U.S.S.R.; and, fourthly, scientific problems connected with the rehabilitation of regions liberated from the German invaders and devastated by war, and further development of the national economy as a whole.

Plans for the year's work were drawn up by each institute separately, primarily by laboratories and then for institutes as a whole. A committee from each institute selects from its programme problems which offer the greatest interest for inclusion in the general plan of the Academy. Plans are then approved at a general meeting of members of the Academy, corresponding members, and leading scientific workers of each section of the Academy, which examines the subjects submitted in detail and draws up a plan for each section of the Academy. The Academy has eight sections covering the following branches of knowledge: physics and mathematics, chemistry, geology and geography, biology, technology, history and philosophy, economics and law, language and literature.

The 1944 plan which was approved by the presidium of the Academy on December 21, 1943, shows that the Academy is devoting the greatest amount of attention to big theoretical and practical research tasks, on the assumption that other questions can be better dealt with by institutions which work in special spheres and branches of industry.

In the Section of Physics and Mathematics, cosmic rays and the structure of the atomic nucleus will be studied by Dr. A. Alikhanov and Prof. D. Skobeltsin. Expeditions to the Pamirs and Mount Elbrus are being organized to study cosmic rays at high altitudes. The building of a cyclotron has been planned. Dr. P. Kapitza and his colleagues will continue their investigation on properties of matter at temperatures approaching absolute zero. The problems of the structure of matter are being worked at in the Physico-technical Institute by Joffe, and in the Institute of Crystallography by Prof. A. Shubnikov; at the Institute of Physics, S. Vavilov is working on mechanics, luminosity and the employment of luminescence. At the Institute of Mathematics, I. Vinogradov, S. Sobolev, A. Kolmogorov and S. Bernstein are working on theoretical mechanics and giving particular attention to methods of employing calculating machines to solve equations arising in mathematical physics.

In chemistry, work will proceed on the development of modern conceptions of chemical bonds in the kinetics and catalysis of chemical reactions (N. Semenov, Prof. S. Roginsky). Frumkin and his school will continue their work on theoretical questions connected with electrode processes and the theory of surface phenomena. Work on the synthesis of carbon compounds of high molecular weight is proceeding. The chemical institute of the Academy of Sciences is devoting considerable attention to scientific and technical assistance to industrial enterprises, employment of new chemical and technical processes and their intensification, and also the rehabilitation economy of devastated regions which have been liberated from enemy occupation.

The programme for geology and geography includes the study of the main questions of stratigraphy and tectonics of the U.S.S.R., the mineralogy and the geochemistry of the formation and distribution of ore deposits. P. Stepanov will continue his work on the theory of coal formations in the world; V. Obruchev and his colleagues will work on the theoretical and practical problems connected with perpetually frozen territories. The work is being extended to the spheres of hydrogeology and the study of lakes and volcanoes. Work on the study of geography in the Soviet Union and foreign countries, and research work on processes taking place in the soil will be continued.

Each biological institute will work on its own special problems, but will handle them from the evolutionary point of view, developing them all as a complex whole in accordance with the basic problem of biology, that of Darwinism. The institute of evolutionary morphology is studying the laws governing that branch of biology. In the institute of palæontology, Borisyak has established a system of practical phylogenesis for the determination of evolutionary processes in fossils. The institute of physiology (Leon Ordeli) is concerned with the evolutionary processes of various systems of the human organism, muscular, neural, etc. Trofim Lysenko, of the Institute of Genetics, is continuing his work on inheritance.

Work on the humanities includes the study of Russian history, peasantry and working class collectivization, Russian culture, patriotic war, study of Slavonic peoples and the history of international relations. Further volumes, "History, Philosophy", will cover Russian philosophy and the philosophical views of Marx, Engels, Lenin and Stalin.

The mobilization of the country's resources for the needs of defence includes the study of problems connected with the industrialization of Kazakhstan. Work on the oil of new oilfields in Bashkiria continues.

In order to help rehabilitation economy in districts that have been devastated by enemy occupation and by war in general, and to help the general development of national economy, the problem of post-war provision of electrical energy is receiving urgent attention and fundamental principles are being laid down. Research is being done on the restoration of the Donets coal basin and its coalmines; industrial enterprises and transport are being greatly extended. The Academy's institute of economics is working on a very comprehensive publication, "Soviet Economy in the War and Post-War Periods".

## EARLY ASTRONOMY

THE third of the series of articles on early astronomy appearing in *Sky and Telescope*, published in the February issue, deals with the Polynesians (see also *Nature*, April 15, p. 459). In this article it is shown that, contrary to earlier views, these people had an intimate knowledge of the constellations and hundreds of stars. They studied the motions of the planets and the phases of the moon, which were used to indicate lapses of time, and they possessed an extraordinary aptitude for making meteorological forecasts.

In navigation the Polynesians displayed remarkable skill; their method of sailing was usually to steer north or south until they reached the latitude of the chosen island, and then to steer east or west. They made use of the "sacred calabash" for determining the latitude. This consisted of a large gourd in which four holes were bored at the same height near the neck. An accurate horizontal plane was provided by the level of the water at these holes, and a sight through a hole over the opposite edge at a bright star gave the angle of its height above the horizon. By placing the holes at the correct distance below the edge to indicate the latitude of their destination, they knew when to turn east or west to reach the island of their quest. Their long sea journeys proved that the earth was round thousands of years ago.

The Polynesians nearly everywhere commenced the new year on December 1, with the first new moon after the first appearance of the Pleiades in the eastern sky in the evening twilight. In the Hawaiian islands twelve lunar months of thirty days each were used, and the religious year was correlated with the sidereal year by introducing five extra days. The months were divided into three periods of ten days each. The origin of the world was explained by various legends, but some of the fundamental ideas were similar, and a primitive egg was the natural beginning. The darkness of the earth was removed by the raising of the sky and letting in the light of dawn.

In the March issue of *Sky and Telescope* there is a brief reference to the astronomy of the Chinese, Indians, Phœnicians, Greeks and Egyptians. Although the inclination of the ecliptic was determined very accurately by Chou Kung in 1100 B.C., yet this eminent mathematician failed completely in his estimate of the sun's distance, as he calculated from the hypothesis of a flat earth. It is remarkable that, though the Phœnicians were expert navigators, yet they have left no other evidence of their astronomical knowledge.

A few of the attainments of the outstanding astronomers and mathematicians of Greece and Egypt are mentioned in this article, and among these we may refer to Aristarchus of Samos, born in 310 B.C., who attempted to measure the relative distances of the moon and sun by a principle theoretically sound, but beset with practical difficulties which rendered it useless. He assumed that at half-moon the angle at the moon between the directions of the sun and the earth was 90°, and if he could measure the angle subtended at the earth by the lines earth-moon and earth-sun, he could solve the triangle of which one angle was a right angle. Unfortunately, a very small error in either of these angles would be responsible for a considerable error in determining the relative distances of the sun and moon, because the ratio of their distances depends on the small angle at the sun subtended by the earth-moon line, and this angle is very sensitive to errors in either of the other angles. Aristarchus obtained a value of the ratio of the distances of the moon and sun which was about twenty times too great, thus making the sun very close to the earth—about twenty times the moon's distance. Aristarchus had the courage to suggest publicly that the earth was a planet and revolved round the sun like the other planets—a view for which he was charged with impiety.

## THE WHITE BUTTERFLY IN NEW ZEALAND

IN the *New Zealand Journal of Science and Technology* of June 1943, J. Muggeridge, of the Department of Scientific and Industrial Research, gives an account of the introduction of parasites of the small cabbage white butterfly (*Pieris rapæ*) into New Zealand. Two species of parasite are taken into consideration, namely, the Braconid *Apanteles glomeratus* and the Chalcid *Pteromalus puparum*. Following the entry of the same species of white butterfly into North America, the Braconid species just mentioned was introduced from Europe in an effort to obtain a measure of control over the pest in question.

There seems little doubt regarding the soundness of this procedure since the insect is considered to be one of the most important agents destroying the caterpillars in North America to-day. This conclusion naturally suggested the possibility that the Apanteles would similarly parasitize, and so destroy, the caterpillars of the butterfly in New Zealand. Acting on these foundations, upwards of half a million cocoons of the Apanteles were introduced from England into New Zealand during the years 1931–34. Liberations were made in various localities, but in spite of intensive field surveys the creature appears to be no longer present.

During 1938–39 about six thousand American-bred Apanteles were introduced, and all the evidence indicates that these have become successfully established. The behaviour of the European *Apanteles glomeratus* contrasts sharply, therefore, with that of the American-bred form. The Pteromalus is a parasite of the pupa of the butterfly. Its larva kills the pupa and the adult Chalcid emerges through a small hole made in or near the region of the wing of the future butterfly. The male Chalcids remain near the pupæ from which they have issued and wait there for the appearance of the females with which they mate. This parasite was sent to New Zealand while still within the pupæ of the butterfly and was first introduced during 1932–33 when about five hundred of these chrysalides were shipped. From out of these hosts more than twelve thousand adult parasites emerged and nearly nine thousand were liberated in the field in 1933. From a field survey made at the latter end of the same season it was found that out of 415 collected butterfly pupæ 58 per cent had become parasitized. The species thus became established with remarkable rapidity and is exercising a useful degree of control. As the author remarks, it has spread rapidly from the points where liberations were originally made, even as far as eighty miles in the first season, and it has had a marked influence in reducing the butterfly population and the damage

caused by the caterpillars. It has been found to be extremely efficient under dry conditions, where the bulk of the Cruciferous crop is grown, but in places with a high rainfall the butterfly seems better able to live than the parasite. It is suggested that this seeming failure might be offset by the introduction of some other larval parasite and one better fitted to withstand the conditions in such areas.

## FORTHCOMING EVENTS

### Saturday, July 1

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES' BRANCH) (in the Physics Department, Imperial College of Science and Technology, South Kensington, London, S.W.7), at 2 p.m.—Conference on "Applied Spectroscopy". (Prof. H. Dingle: Introductory Address; Mr. F. Twyman, F.R.S.: "Spectroscopic Instruments"; Mr. D. M. Smith: "Spectrographic Analysis"; Dr. W. A. Roach: "The Determination of Mineral Deficiencies and Excesses in Plants by Spectrographic Analysis"; Dr. R. W. B. Pearse: "Applications of Molecular Spectra").

### Monday, July 3

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Austrian Centre, 69 Eton Avenue, Hampstead, London, N.W.3), at 7.30 p.m.—Dr. I. Broda: "Prominent Austrian Scientists".

### Tuesday, July 4

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1), at 2 p.m.—Colonel Prof. A. T. Jurasz: "Former and Post-War Health Problems in Poland" (Lloyd Roberts Lecture).

### Friday, July 7

ROYAL ANTHROPOLOGICAL INSTITUTE (joint meeting with the INTERNATIONAL AFRICAN INSTITUTE) (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Mr. P. P. Howell: "The Installation of the Shilluk King".

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. Maurice Black: "Limestone Depositions in the Bahamas".

### Thursday, July 6—Sunday, July 9

BRITISH RHEOLOGISTS' CLUB (at St. Hilda's College, Oxford).—Conference.

**Friday, July 7**

10 a.m.—"Rheology of Large Deformations and Plastic Flow", (a) Plasticity of Metals; (b) Polymers; (c) The Liquid State.

2.15 p.m.—"Relations between Shear, Tension and Compression in Complex Bodies (The pi-problem)".

5 p.m.—"Some Rheological Applications to Medical Science".

**Saturday, July 8**

10 a.m.—"Rheological Nomenclature and Symbols Metallurgical and Non-Metallurgical".

8.30 p.m.—"Future Organisation of Rheology".

## APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT MASTER (full-time, graduate preferred) to teach mainly MATHEMATICS and SCIENCE in the Junior Building School of the Accrington Technical School—The Director of Education, Broadway Chambers, Accrington (July 4).

CIVIL ENGINEER as Chief of Construction Department with an Oilfield Company in Peru—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.1010XA) (July 5).

ELECTRICAL INSPECTOR OF FACTORIES (temporary) in the North-West of England—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.798A) (July 5).

SENIOR ASSISTANT DRAINAGE AND IRRIGATION ENGINEER (Reference No. E.902A), and a JUNIOR ASSISTANT DRAINAGE AND IRRIGATION ENGINEER (Reference No. E.903A), by the Sierra Leone Government —The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting appropriate Reference No.) (July 5).

EXECUTIVE ENGINEER by the Sierra Leone Government—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.1011A) (July 5).

SPEECH THERAPIST (full-time, temporary)—The Director of Education, Education Offices, 14 Sir Thomas Street, Liverpool (July 7).

TEACHER OF ENGINEERING SCIENCE AND MATHEMATICS, and a TEACHER OF ELECTRICAL ENGINEERING, SCIENCE AND MATHEMATICS in the Bootle Municipal Technical College—The Director of Education, Town Hall, Bootle (July 7).

LECTURER (full-time) IN THE DEPARTMENT OF MECHANICAL ENGINEERING—The Principal, Derby Technical College, Normanton Road, Derby (July 8).

SPEECH THERAPIST to the St. Helens and Wigan Education Committees—The Director of Education, Education Office, St. Helens, Lancs. (July 8).

TEACHER (full-time) IN TEXTILES in the Oldham Municipal Technical College—The Director of Education, Education Offices, Oldham (July 8).

TECHNICAL CHEMIST (Reference No. F.2012XA), and a LABORATORY ASSISTANT (Reference No. F.2503XA), by London Paint Manufacturers —The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting appropriate Reference No.) (July 8).

LECTURER (full-time) IN PHYSICS—The Principal, Royal Technical College, Salford (July 10).

AGRICULTURAL ENGINEER for the Ceylon Government Department of Agriculture—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2189A) (July 10).

ASSISTANT VETERINARY INVESTIGATION OFFICER at the Agricultural Advisory Centre—The Secretary and Registrar, The University, Bristol (July 14).

PSYCHIATRIST (part-time, man or woman), an EDUCATIONAL PSYCHOLOGIST (woman), and a PSYCHIATRIC SOCIAL WORKER (woman), in the Child Guidance Service in the North Riding—The Secretary, Education Offices, County Hall, Northallerton (July 15).

SPEECH THERAPIST—The Director of Education, Shire Hall, Nottingham (July 15).

ASSISTANT LECTURER AND DEMONSTRATOR (woman) IN ZOOLOGY—The Principal, Royal Holloway College, Englefield Green, Surrey (July 15).

DEMONSTRATOR (man or woman) IN THE DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (July 17).

CHEMISTS (temporary) with considerable experience in analysis of metals—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2628A) (July 25).

LECTURER IN EXPERIMENTAL PHYSIOLOGY—The Registrar, The University, Sheffield (July 28).

ASSISTANT SECRETARY to the Oxford and Cambridge Schools Examination Board—The Chairman of the Oxford Delegacy, St. Catherine's Building, St. Aldate's, Oxford (July 31).

READERSHIP IN PHYSICAL ANTHROPOLOGY—The Registrar, University Registry, Oxford (August 31).

MISTRESS TO TEACH BIOLOGY AND GENERAL SCIENCE in the Day Technical School for Girls and the Day Technical School for Boys, a TEACHER OF ENGINEERING SUBJECTS, and a MATHEMATICS MASTER —The Principal, Technical Institute, Gravesend.

LECTURER (full-time) IN ENGINEERING SUBJECTS in the South-East London Technical Institute, Lewisham Way, London, S.E.4—The Education Officer (T.1), County Hall, Westminster Bridge, London, S.E.1.

TECHNICAL ASSISTANT (male or female) for abstracting and preparing bibliographies and summaries of technical articles mainly in Electrical Engineering and Applied Physics—British Electrical and Allied Industries Research Association, 15 Savoy Street, London, W.C.2.

## REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

Colonial Development and Welfare Act, 1940. Return of Schemes made under the Colonial Development and Welfare Act, 1940, by the Secretary of State for the Colonies with the concurrence of the Treasury in the Period from 1st April 1943, to 31st March 1944. (Cmd. 6532.) Pp. 16. (London: H.M. Stationery Office.) 3*d.* net. [

Colonial Research Committee. First Annual Report, 1943–44. (Cmd. 6535.) Pp. 12. (London: H.M. Stationery Office.) 2*d.* net. [86

Empire Cotton Growing Corporation. Report of the Administrative Council of the Corporation submitted to the Twenty-third Annual General Meeting on June 6th, 1944. Pp. 16. (London: Empire Cotton Growing Corporation.) [86

School Certificate Mathematics. Report of a Conference of Representatives of Examining Bodies and Teachers' Associations, with a suggested Alternative Syllabus and Specimen Papers. Pp. [illegible] (London: Mathematical Association.) [136

### Other Countries

Sixtieth Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1942-1943. Pp. 10. (Washington, D.C.: Government Printing Office.) [16

Annals of the New York Academy of Sciences. Vol. 45, Art. 6: Experimental Modification and Control of Molts and Changes of Coat-Color in Weasels by Controlled Lighting. By Thomas Hume Bissonnette and Earl Elmore Bailey. Pp. 221–260 + 7 plates. (New York: New York Academy of Sciences.) [16

Proceedings of the United States National Museum. Vol. 94, No. 3175; A Revision of the Embioptera, or Web-Spinners, of the New World. By Edward S. Ross. Pp. 401–504 + plates 18–19. (Washington, D.C.: Government Printing Office.) [16

Educational Wallsheet No. 3: The Louse. 22¼ in. × 17¼ in. (Cape Town: The African Bookman.) [16

Bulletin of the American Museum of Natural History. Vol. 82, Art. 6: Comparative External Morphology, Phylogeny, and a Classification of the Bees (Hymenoptera). By Charles Duncan Michener. Pp. 151–326. (New York: American Museum of Natural History.) [56

Bulletin of the National Research Council. No. 108: The Problem of Changing Food Habits: Report of the Committee on Food Habits, 1941–1943. Pp. 177. (Washington, D.C.: National Academy of Sciences.) [56

# NATURE

No. 3897 SATURDAY, JULY 8, 1944 Vol. 154


## CONTENTS

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# THE APPROACH TO FULL EMPLOYMENT

THE publication of the White Paper on Employment Policy almost on the eve of the launching of the invasion to liberate the peoples of occupied Europe was an imaginative stroke. It has both strengthened confidence in the determination of the Government to pursue resolutely a policy which will effectively implement its declared aim of maintaining a high and stable level of employment after the War, and fortified the nation for whatever may be demanded of it in the weeks that lie immediately ahead. More, it represents not merely a new departure in Government policy and an example of real leadership, but also, in some respects, the shaping of policy in accordance with scientific principles. To the fundamental statements and principles set forth in the report there can be little or no exception. Opinions may indeed differ as to the methods by which particular points of policy are to be implemented, and as to whether those which the Government proposes to use in the first instance are likely to be effective enough, or put into practice with sufficient firmness. Beyond this, however, a great merit of the statement is that it makes unmistakably plain, while acknowledging the Government's responsibilities in the matter of policy and decision, that there are limits beyond which Government action cannot go, and that the success of an employment policy must depend very largely on the understanding and support of the community as a whole. Whether or not the Government could do more than is indicated in this statement to promote a rising standard of industrial efficiency, such action could not be effective without corresponding efforts from both employers and workers. Without such co-operation, even measures already proposed by the Government may be frustrated of their purpose.

If for nothing else, this statement therefore is to be welcomed for its educational value. In the problems of the transition from war to peace—such as demobilization, the necessity for continuing war-time controls, the transfer of workers, their re-training and other measures to increase their mobility—the position is lucidly explained and reasons are given which should go far to assist in gaining public assent and co-operation in proposals which may to some extent be unpalatable and involve a break with professional or trade custom or practice. The necessity of explaining policy and measures in advance has been repeatedly urged in connexion with demobilization and like problems, notably in a valuable report, "The Organization of Employment in the Transition from War to Peace", submitted to the International Labour Conference at Philadelphia, and the White Paper is fully in keeping with the recommendations and spirit of that report. Any demobilization scheme finally agreed upon should be clearly understood by the people and the interests affected by it. If, as the report observes, the scheme is widely discussed, and if, after discussion, it is accepted as fair and reasonable, then some of the pressures apt to cause disorderly mobilization can be relieved or abolished.

Again, not only is it a matter of winning public approval of what is involved in policy. The Government also recognizes that, in its proposals for extending State control over the volume of employment, it is entering a field where theory can only be applied to practical issues with confidence and certainty when experience accumulates and experiment extends over untried ground. It is intended, therefore, to establish on a permanent basis a small central staff qualified to measure and analyse economic trends, and to submit appreciations of those trends to the Ministers concerned. It is also vital for the Government to obtain, more fully and much more quickly than in the past, exact quantitative information about current economic movements, and the Government appeals to industry for co-operation in this task. Only industry can provide the statistical information required, and only a central authority can classify and analyse information drawn from the country as a whole.

In this respect the White Paper points out that the efficient operation of an employment policy will require statistics of employment and unemployment, including quarterly or monthly statements of present and prospective employment in the main industries and areas of Great Britain, based on returns from employers, as well as regular information relating to savings, projected capital expenditure by public authorities, and, so far as possible, by private industry. An annual census of production showing the structure of the main groups of industries in the preceding year, including, *inter alia*, details of the quantity and value of output, stocks, and work in progress, together with monthly figures of production, consumption and stocks, and, if possible, figures of orders on hand, based on sample returns obtained periodically throughout the year from large firms, trade associations and public institutions, must also be provided. The Government has already repeatedly affirmed its intention of extending the provision of official statistics after the War, and it is now stated that the annual White Paper on National Income and Expenditure is to be developed by providing a much more complete analysis of the constituent parts of the country's total expenditure.

This central analysis of our financial position, which will be subject to continuous review and adjustment throughout the year, will serve as a basis for determining what measures are required to maintain employment and secure a rising standard of living. Parallel studies, at every stage, of the man-power situation will be undertaken by the Ministry of Labour and National Service, and these surveys will indicate the probable supply of labour over the coming period, the prospective changes in employment in the different industries, and the effects upon employment of Government projects designed to modify the volume of investment or expenditure. The correlation of these complementary budgets—for total expenditure and for man-power—will play a vital part in the formulation of Government policy for the maintenance of employment.

The debates on the Budget will in future provide an annual opportunity for Parliament to review the financial and economic health of Great Britain as a whole, and to consider the prospects for the coming year. This step may be regarded as part of the programme of educating the country as to what is required in a policy of employment which at the same time aims at securing for the nation the most effective use both of its man-power and of its material resources. Measures to increase total expenditure at the onset of a depression will no doubt be welcome; but the restraining measures appropriate to a boom may meet with opposition unless they are seen and understood as part of a continuing policy for maintaining employment, and accepted as the price that must be paid for the success of that policy over a long period.

It is right that we should turn first to the measures by which the Government seeks to provide itself with the instruments for giving effect to policy in this field, for unless the appropriate instruments are available and the basic data accumulated in readiness, the right decisions and the appropriate policy may not be determined or effectively put into operation. The White Paper, however, shows that in breaking new ground in regard to policy, the Government is providing itself with exactly the instruments required for the formulation of policy for which scientific workers have long pressed. No point, in fact, was more strongly urged in the Barlow Report, for example, than the necessity for more fact-finding machinery in regard to the location of industry and the natural resources that might be affected by industrial location, and the Commission was unanimous in recommending that the functions of the new national authority proposed should include the collection and co-ordination of such information.

Whether the instruments proposed by the Government will in fact prove adequate remains to be seen, and can scarcely be judged until the fuller proposals on particular points are made known. In regard to the collection of statistics, some further organization more on the lines of that recommended by the Council of the Royal Statistical Society in its Memorandum on Official Statistics (see *Nature*, **153**, 88; 1944) may prove necessary; this may indeed be contemplated by the Government, although it is not explicitly mentioned in the White Paper. The provision of statistics cannot be left to returns supplied by industry itself alone, however important the co-operation of industry may be. Nevertheless, it is clear that we have something more of a scientific approach to questions of public policy.

Turning now to the question of policy, the White Paper visualizes some ten different methods by which the Government may influence employment in furtherance of its objective. First, there is the action to be taken in the period of transition from war to peace, to avoid the threefold danger that patches of unemployment may develop where the industrial system fails to adapt itself quickly enough to peace-time production; that demand may outrun supply and create an inflationary rise in prices; and that civilian production, when it is resumed, may concentrate on the wrong things from the point of view of national needs. It is clear from the White Paper

that the Government is fully alive to these dangers; it will be recalled that the report presented to the Philadelphia Conference directed attention to them, as did also an admirable study issued last year by the League of Nations Delegation on Economic Depressions (see *Nature*, **152**, 365; 1943). In regard to the first, plans are being worked out to promote the orderly expansion of peace-time industries throughout the transition period by assisting firms to switch over their capacity to peace-time production as quickly as possible, by finding out in advance where the skilled labour which will gradually become available will be most urgently required, and by arranging, so far as war conditions permit, that labour and raw materials will be forthcoming for urgent civilian work. Steps are being taken to ensure that the machinery of allocation devised in war-time will be adaptable to the special conditions likely to obtain after the end of the War in Europe. Curtailments of munitions production will be made first in areas where the capacity and labour can be used for civilian products of high priority. The disposal of surplus Government stocks will not be allowed to prejudice the re-establishment and development of the normal trade channels for producing and distributing similar goods; and the disposal of Government factories will be regulated so as to help towards the early restoration of employment.

In regard to the second danger, the White Paper insists on the need for public support for such measures as the continuance of rationing and a measure of price control; but it is emphasized that there is no intention of maintaining war-time restrictions for restriction's sake. Some controls there must be; the habit of saving must still be encouraged, though, as Lieut.-Colonel K. E. Edgeworth points out in his book, "Unemployment Can Be Cured" (see p. 40 of this issue), the vital question is how much saving: over-saving can create unemployment. There must be discipline and imagination in peace no less than in war, and nothing will so speedily ensure that the peace is lost as the same craving for indulgence in an easy peace that we yielded to in 1918–20. Again, to avert the third danger it will be necessary to establish certain broad priorities, and to enforce them for a time by means of the issue of licences, the allocation of raw materials and a measure of control over the labour and staff required for industry.

The reasons for all these measures are well put in the White Paper, and this is equally true of the second field, namely, those concerned with the expansion of our external trade, by the creation, through collaboration with other nations, of the conditions of international trade which will make it possible for all countries to pursue policies of full employment to their mutual advantage. Here again the White Paper emphasizes that it is with industry that the responsibility and initiative must rest for making the most of opportunities to recover export markets and to find fresh outlets for products. While this is true, there is a slight tendency to discount the full measure of Government responsibility for securing the conditions in which such expansion can best be promoted, and a like comment might be made on the White Paper's observations on the promotion of industrial efficiency. There is a disposition to regard recent taxation concessions in regard to research and obsolescence as a sufficient contribution; more may well be expected of the Government in this respect than is indicated. The promotion of industrial efficiency is a matter of paramount importance that must be kept under constant review, and further measures will almost certainly be required.

A whole chapter of the White Paper is devoted to the fourth series of measures, namely, those designed to secure the balanced distribution of industry and labour; and this has already been the subject of a debate in the House of Commons, in which attention was once again directed to the Barlow Report. Dealing first with the problems of local unemployment as presented in the 'distressed' or 'special' areas, Mr. Dalton, president of the Board of Trade, said that it is proposed to discontinue the use of these terms; these areas will in future be known as 'development areas'. The Government proposes to attack these problems in three ways: first, by so influencing the location of new enterprises as to diversify the industrial composition of areas which are particularly vulnerable to unemployment; secondly, by removing obstacles to the transfer of workers from one area to another, and from one occupation to another; and thirdly, by providing training facilities to fit workers from declining industries for jobs in expanding industries.

Mr. Dalton's speech showed that the Government's policy for the location of industry goes a good deal further than is indicated in the White Paper itself. Mr. Dalton stated that the Government has now explicitly accepted the two main ideas of the Barlow Report, namely, the spreading out of the very congested areas over wider areas, and the encouragement of a reasonable balance of industrial development as between the various regions in Great Britain and the suitable diversification of industry within each region. Mr. Dalton was at pains to point out that the Government is already in possession of powers to enable it to exercise a substantial influence over the location of new industrial development, both to prohibit the establishment of a new factory in a district where serious disadvantage would arise from further industrial development, and to steer new factory development into areas which call most urgently for further industrial diversification. It is clear, however, from the debate, that Mr. Dalton was unable to convince the House of Commons that the Government is in earnest in this matter, or that without new powers, it is able to implement the policy disclosed even in the White Paper.

Sufficient reason for such scepticism may well be found in the simple fact that the fundamental recommendation of the Barlow Report—the establishment of a central planning authority, whether advisory as recommended by the majority, or executive as recommended by the minority—is ignored. Mr. Dalton, in indicating his support of the minority proposal, suggested that the required department exists in the Ministry of Town and Country Planning. This

suggestion will satisfy no one who appreciates the importance of a definite policy for the utilization of the land. The location of industry cannot be guided without planning the use of land. The Ministry of Town and Country Planning is neither equipped nor authorized to carry out the function of the central planning authority visualized unanimously by the Barlow Commission as extending far beyond the powers of any Government department then existing, and extending to "continued and further redevelopment of congested urban areas where necessary ; decentralization or dispersal, both of industries and industrial population, from such areas ; and encouragement of a reasonable balance of industrial development—coupled with appropriate diversification of industry in each division or region throughout the country". The Ministry, it should be remembered, represents not an accretion of new departmental power, but an aggregation of powers and functions from existing departments, and we need look no further than to the history of the Butlin proposal to establish a holiday camp on the Lleyn peninsula for an apt illustration of the limitations of its present powers.

The same chapter of the White Paper covers a further method which the Government also intends to use. The mobility of labour is an important factor both in reducing the dislocation which arises from changes in technique and fluctuations in market conditions, and also in ensuring that the expansion of new industries under the stimulus of a high level of demand is not hampered by a shortage of skilled labour. Such mobility is an essential feature of a full employment policy, but it by no means involves of necessity the large-scale transfer of population, and it seems clear from the White Paper and from the debate that such transference is not contemplated by the Government. Some geographical flexibility and mobility there must be, but much more important is mobility of skill, and the readiness and capacity to transfer from one occupation to another. That was the point on which Mr. G. H. D. Cole insisted in his Mather Lecture to the Textile Institute, and the acquisition of at any rate two kinds of skills should be an objective in the policy of technical education which, in view of its bearing on industrial efficiency, must be a counterpart to any employment policy.

These five methods directly concern many scientific workers. The remaining five, though more of indirect interest, may well prove even more important in ensuring the success of an employment policy. Put briefly, they may be described as the stabilization of private investment, public works, the maintenance of consumer purchasing power, the stabilization of prices and wages, and the discouragement of restrictive practices. In regard to the maintenance of total expenditure the White Paper sets forth as the guiding principles of the Government's policy, first an increase in exports ; secondly, the limitation, so far as possible, of dangerous savings in expenditure on private investment ; thirdly, the careful planning of public investment both in timing and in volume to offset unavoidable fluctuations in private investment ; and lastly, readiness to check and reverse the decline in expenditure on consumers' goods which normally follows as a secondary reaction to a decline in private investment.

One scheme contemplated by the Government when the abnormal conditions of the immediate post-war years have disappeared is for varying social insurance contributions in accordance with a forecast of the average level of unemployment, the rate of contribution actually levied increasing when unemployment falls below the estimated average level and decreasing when unemployment exceeds that level.

In regard to restrictive practices, the White Paper contains warnings both to employers and to workers. An undue increase in prices due to causes other than increased wages might frustrate action taken by the Government to maintain employment ; for example, if additional money made available by the Government to maintain employment were absorbed in increased profit margins through the formation of a ring by the manufacturers in a particular industry for the purpose of raising prices, and no increase in employment resulted. Trade union practices and customs may equally constitute a serious impediment to an expansionist economy and so defeat the object of a full employment programme ; and they, too, must be examined by workers themselves. There is a note struck here which professional associations of scientific workers will do well to heed, for no professional association long remains altogether free from a restrictionist outlook, which may be at issue with the public interest. Nothing is healthier in the White Paper than this appeal to put the public interest before sectional interest or advantage, and to tolerate no arrangements which obstruct or impede public policy. It is on the response to this appeal that we may best found our hopes of the success of an employment policy.

Critics have already pointed out that the policy outlined in the White Paper is not, except perhaps so far as the transition period from war to peace is concerned, a policy of full employment. It does not propose positive steps to provide jobs at all times for all workers by ensuring that the real needs of the people for housing, health, education and good living are met continuously, to the exclusion, if need be, of demands for less essential things. Much will depend on the other measures in the Government's reconstruction programme, notably on the social security proposals and those for dealing with the use of the land, and the problems of compensation and betterment considered by the Uthwatt Committee.

None the less, the welcome given to the Government's proposal in the three-day debate in the House of Commons to create an economic general staff is a sign of a new approach to the problem of employment and of a realization of the importance of a factual basis for policy. The criticism launched at the White Paper in the debate should dispel any false ideas or extravagant hopes: the means by which rising wages are to be linked with increased productivity are yet to be delineated. The emphasis was placed on the promotion of industrial efficiency, and Sir John Anderson stressed the need for

developing a new technique of control to cover both privately and publicly owned industry.

The White Paper thus outlines a policy which merits the serious attention not merely of the specialist but also of the ordinary citizen, as a further step towards a scientific approach to some of our major economic problems. But no measures put into operation to implement that policy will have their full effect without the co-operation and intelligent support of the whole community. This can come only through full debate and discussion, whereby the country can be fully educated as to the magnitude of the issues and the extent to which co-operation and acceptance of restraints may be required of every individual.

## SCIENCE AND BROADCASTING

### Reshaping Man's Heritage

Biology in the Service of Man. By J. S. Huxley, H. G. Wells, J. B. S. Haldane, W. G. Ogg, J. C. Drummond and W. F. Crick, J. W. Munro and J. Fisher, W. H. Kauntze, L. J. Witts, Major P. G. Edge, J. M. Mackintosh, Sir E. V. Appleton. Pp. 96+7 plates. (London: George Allen and Unwin, Ltd., 1944.) 5*s*. net.

"RESHAPING MAN'S HERITAGE" comprises a series of talks which were broadcast round the theme that, by the use of science, man is achieving greater freedom as well as surer control of his heritage. The series was introduced by H. G. Wells, who spoke about man's accomplishments, opportunities and pitfalls. The other contributors are specified under the title-heading above and their talks included such subjects as man's food, the good earth, reshaping plants and animals, the conquest of the germ, the banishment of pain, and preventive medicine.

Of the talks themselves little need be said. The subjects were chosen carefully, the whole group was well co-ordinated, and the names of the distinguished persons who gave the talks lent sufficient appeal to attract the mass of listeners for whom they were intended. Further, the language used by the speakers was sufficiently clear and non-technical to make the presentation one that should not have taxed any listener unversed in science.

Yet this group of broadcasts raises a problem which will need close attention by men of science. The present writer was privileged to arrange the series as material for an army listening group. The men and women who attended were mostly of a fair standard of education and intelligence, and, although their knowledge of science was limited, attended the broadcasts voluntarily. What were their reactions? It cannot be said that the interest of the Service men and women was aroused to any extent or that they were highly stimulated. In the main the talks were borne patiently, and little animation developed. It was difficult to find out why the majority of talks did not attract, but experience with other army groups may help to throw some light on the matter.

Since the War-Time Army Education Scheme was introduced in 1940, many thousands of talks and lectures have been given to troops on all kinds of 'educational' topics. Those which have been outstandingly successful have been derived from personal experiences of the speaker—travel, exploration, particular employment, etc. (The talk in this series on the control of rats reminds one of the broadcast some months ago by a Cockney rat-catcher on how to trap rats. His methods may not necessarily have been the most successful ones, but troops are still discussing the talk.) Talks which have met with least response have been those which the audiences consider to be academic and detached from their lives. Here lies the crux of the problem.

If we wish to interest the masses in the impact of science on society—we assume that the person who arranged this series of elementary talks wished to interest as many listeners as possible—we must first recognize that the ordinary man and woman only too often regard science as academic and aloof, and are not infrequently a little afraid of it. It is essential, therefore, when planning a programme of popular science talks, to ensure that the subjects chosen fall within the daily interest of the listener. On this score alone, the series under discussion could have been little improved upon. The fault, if fault there be, lay with the presentation.

The time is long overdue when men of science, among others, began to learn of the effect which their discoveries have made, and are making, on the masses of the people. One shilling will produce a comfortable seat 'at the pictures' where education can be absorbed pleasantly and without physical and mental exertion. A third of a shilling will produce a weekly journal where the many photographs are seductively displayed and unencumbered by much wearisome reading matter. These—and others—are the educative rods which inventive man has made for his own back.

How can these opiate effects be combated? It is not enough merely to say that we must raise the standard of films or give John Citizen more information on how or what to read. We must also use the weapons available now and help John Citizen to want to raise the standards himself. Broadcasting is one of the tools. But we must attend to presentation. In this connexion we may take a hint from the Schools Broadcasting Department. When a particular broadcast is being prepared, as much time is given to the way in which a topic is to be 'put over' as to the subject-matter itself. Straight talks, even of fifteen minutes duration, are seldom given. The appeal of different voices has been recognized and the question-answer or discussion method between two or more people is frequently used. (Of the twelve broadcasts under the heading of "Reshaping Man's Heritage", ten were straight talks; two consisted of dialogue conversation.) Again, when a straight talk is given, much more attention is paid to the speaker's degree of 'mike-worthiness' than is the case with the Adults Talks Department of the B.B.C. That a man or woman is an authority on a particular subject is not enough to make him a good broadcaster. He should have a microphone manner which will appeal to the largest body of listeners and make them want to listen again to the broadcast of a related subject. With the exception of two, and possibly three, of the speakers in "Reshaping Man's Heritage", how many succeeded in making the listeners anxious to obtain further information about these all-important issues?

It may rightly be argued that there are few men—and less women—who are expert in a particular field and yet naturally have a microphone personality which is acceptable to the majority of listeners.

It is a remarkable fact that the number of first-rate broadcasters on any special subject number less than half a dozen. How, then, can science topics be presented to make the appeal which they inherently possess for the bulk of the population ?

One of the answers lies in the greater use of feature programmes. Script-writers of the calibre of Louis MacNiece would have made any of the topics of "Reshaping Man's Heritage" so attractive that many more listeners would have been attracted. It is not suggested that straight talks be eliminated from broadcasting. Great names are themselves an attraction and many people listen at first not for the subject-matter but because Dr. So-and-So is broadcasting. But when Dr. So-and-So is the authority on a particular subject which lends itself to broadcasting and he is not suitable either in manner or personality to make the subject attractive over the microphone—this was even more evident in the recent series "Science at Your Service" than in "Reshaping Man's Heritage"—he might well be asked to prepare a script which could be presented in 'feature' form by skilled broadcasters. To soften criticism on this point, perhaps it is worth mentioning that the B.B.C. has a maxim, developed from experience, that to make a broadcast sound natural it must be 'staged'. Examples of this are constantly being referred to by W. E. Williams in his sagacious column called "The Spoken Word" which appears each week in *The Listener*.

This brings the discussion to its focus. The B.B.C. should have on its directing staff a man of science of the standing of the co-ordinator of "Reshaping Man's Heritage". He should be instructed to develop the place of science in broadcasting and to use the necessary discrimination in the selection—and rejection—of speakers. He should be given a staff whose duty it would be to investigate the various methods of making scientific broadcasts attractive.

In conclusion, it should be said that "Reshaping Man's Heritage" makes good reading for the elementary student wishing to extend his knowledge of the application of biological research to human welfare.

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## CONTROL OF UNEMPLOYMENT

**Unemployment Can Be Cured**

By Lt.-Col. K. E. Edgeworth. Pp. 158. (Dublin: Eason and Son, Ltd.; London: Simpkin Marshall, Ltd., 1944.) 10*s*. 6*d*.

THE conclusions and suggestions put forward by Colonel Edgeworth in this book run closely parallel with the policy set out in the White Paper on Employment Policy. The four serious types of unemployment which Colonel Edgeworth considers need handling are all recognized in the official statement, and the measures he advocates find a place in the Government's policy.

First, for example, there is unemployment caused by fluctuations in the demand for industrial equipment and for buildings, to be remedied by a certain measure of national planning and control over the volume of output. This control, Colonel Edgeworth suggests, might be, as suggested in the White Paper, in part voluntary, assisted and supplemented by an appropriate control of Government expenditure. Secondly, there is unemployment caused by the decline of existing industries owing to the development of new industries of greater technical efficiency. For this the remedy is to facilitate the transfer of the displaced workers to other occupations, the scheme including the cost of training and the payment of wages or part wages during the period of transition. Co-ordination of such transference with plans for the development of housing and for the expansion and location of new industries would also be required.

Thirdly, unemployment is caused by the decline in purchasing power which arises from over-saving. This is the distinctive feature of Colonel Edgeworth's book, where the influence of this factor is worked out in considerable detail and with some approximation to quantitative computation. Fourthly, unemployment is caused, especially in the smaller countries, by the competition of larger and more efficient industries abroad. Apart from this, Colonel Edgeworth just touches on the question of agriculture, to which the White Paper makes only passing reference. Schemes for sustaining agricultural prices by increasing the bargaining power of the farmer in marketing his surplus, national schemes for storing the surplus output of exceptionally good years, and some international planning in respect of international purchases of agricultural products, are among the measures he advocates for securing a healthy and well-balanced agriculture.

Colonel Edgeworth's analysis leads him to conclude that individual saving should not exceed 3 per cent of the national income, and that it can be kept down to this figure by a suitable system of taxation and death duties. Business saving tends to increase with undesirable rapidity when trade expands, and acts as a brake on expansion, preventing the attainment of full employment. To provide the remedy of passing on to the consumer, in the form of reduced prices, the reduced costs which are associated with expanding output, he suggests that the boards of management of all large business enterprises should include representatives of workers and consumers to see that this principle is observed. The volume of Government saving should be determined by the opportunities for utilizing the money in an investment worth while, and if other means of controlling the surplus saving prove inadequate, he suggests that the Government should borrow the surplus savings and expend them on social services, rather than on public works. This is in effect what the White Paper suggests in the differential scheme of contributions to social insurance.

With regard to international trade, Colonel Edgeworth suggests a combination of moderate tariffs with a system of price control through the control of wages and associated with the control of profits. Here he appears to go somewhat beyond the measures the Government is at present prepared to contemplate; but he recognizes that the smooth working of any such scheme will depend very largely on how far each country is prepared to accept the principle that a properly adjusted system of international trade is to everybody's advantage, and that it can only be secured by mutual co-operation.

There can be no question as to the value of Colonel Edgeworth's little book as a stimulant to public interest in these problems and as an indirect comment on Government policy as outlined in the White Paper. It should provoke further discussion on the causes of unemployment and assist to clarify the issues, whether or not the remedies he suggests be regarded as appropriate.

# THE GALACTIC SYSTEM*

By SIR JAMES JEANS, O.M., F.R.S.

THERE is a promontory on Mount Wilson from which the visitor to the Observatory can look down at night and see the lights of Pasadena and Los Angeles on the plain 7,000 ft. below. He cannot distinguish individual lights, but sees two patches of luminosity which indicate the outlines of the cities and the distribution of density—if not of population, at least of the street-lights. It is so easy to study this distribution from up here, and so difficult from inside the cities, where one cannot see the forest for the trees.

This is, of course, an astronomical parable. In the night sky we see a number of distinct stars, and also a far greater number which are merged into the continuous band of light we call the Milky Way. These together constitute the galactic system—the city of stars in which we reside. But far out beyond this we see objects of another kind—the extra-galactic nebulæ—which we believe to be other cities of stars, external to our own.

It is easy to study the distribution of light, and so of stars, in these external galaxies; we need only take a photograph or, better, photometric measurements, and the thing is done. But our own galaxy presents problems of an entirely higher order of difficulty.

If the stars were distributed uniformly through infinite space, the number in a sphere of any size would, of course, be proportional to the cube of the radius of the sphere, and this would lead to the simple law that vision down to stars of one magnitude fainter would increase the number of stars which could be seen fourfold. If the uniform distribution of the stars fell off after a certain distance, this distance would be revealed by the failure of this law. Using this method, the two Herschels studied the distribution of the stars in space, and were led to picture the galactic system of stars as a flat disk, the plane of the Milky Way being, of course, the plane of the disk. This plane is observed to divide our sky into exactly equal halves, and the sky looks about equally bright in all directions in it; whence the Herschels concluded that we are close to the centre of the disk.

At a later date, the globular clusters seemed to tell a different story. These are compact clusters of millions of stars, all being very similar in appearance. So far back as 1911, A. R. Hinks had noticed that they all lie in one half of the sky. A detailed study by Shapley confirmed this—nearly all lie within a range of 130° of galactic longitude. Cepheid variables abound in the clusters, so that their distances are easily measured, and Shapley could map out the distribution of the clusters in space. He found that all except one—possibly a stray—lie in or near a circle of about 100,000 light-years radius, in the galactic plane. But the sun is not at or near the centre of this circle; it is about 40,000 light-years distant. It was natural to think that the boundary of this system of clusters must mark out the limits of the galaxy, but it seemed strange at the time that this did not coincide with the boundary of the visible stars.

The discovery that space is filled with obscuring matter has now removed this difficulty, and brought all the elements of the problem into harmony. Observation shows that this obscuring matter makes a fog of which the density varies greatly in the different parts of space. As might be expected, it is densest in the galactic plane; here a beam of light is halved in intensity after traversing about 3,000 light-years of distance. Thus the range of visibility in the fog is not a very great number of thousands of light-years. The Herschels, and many after them, who did not know of the fog, mistook the range of visibility in the fog for the radius of the galaxy. This is why we seemed to live at the centre of things; for in a fog, we each have our own sphere of vision, of which we are always at the centre.

The figure just mentioned shows that the fog reduces light to a ten-thousandth part of its original intensity in travelling from the centre of the galactic system to the sun. Thus individual stars near this centre are invisible to us, and we see less than a half of the whole system of stars. For the same reason, we cannot see external objects which lie in or near the galactic plane; there is too much obscuring matter between them and us for their light to get through.

If the fog were much denser than it actually is, we should see only the stars in our immediate proximity, and a few of exceptional brightness beyond. If we were unaware of the fog, we should conclude that there is an excessive concentration of stars in our immediate proximity. Astronomers made exactly this mistake for a time, thinking that we lived in the midst of a 'local cluster' of exceptionally bright stars. Now that we know of the fog, we can allow for its effects and, for any assumed density of fog, can calculate the arrangement of stars which will exactly fit the observations. If we under-estimate the fog, we shall obtain a 'local cluster'; while if we over-estimate the fog, we shall get the opposite result, namely, that stars are exceptionally few in our neighbourhood, so that we are living in a 'hole'. Actually both results have been obtained in recent years by different investigators, but the simplest interpretation of their results is, I think, that they have respectively under-estimated and over-estimated the density of fog. There are rather strong reasons for thinking that there can be neither a 'local cluster' nor a 'local hole'—these are, in brief, that the whole galactic system is rotating with different speeds in different parts, so that both clusters and holes would soon be smoothed out. Thus the most likely value for the coefficient of absorption by the fog would seem to be that which just gets rid of the 'local cluster' without replacing it by a 'local hole', and this is about equal to the value mentioned above.

For a long time it was something of a puzzle to understand why a disk-shaped group of stars such as our galaxy should not all fall together at its centre of gravity, and it has often been suggested that our galaxy must be in rotation, as many of the external galaxies are known to be. In 1913 Poincaré calculated that our galaxy could be saved from this fate if it rotated about once every 500 million years. In the same year, Charlier found that the invariable plane of the solar system appeared to be moving against the background of the stars. Now the solar system keeps its invariable plane always fixed in the same direction, just as a spinning gyrostat does, so that, as Eddington immediately pointed out, the apparent motion found by Charlier could only mean that the background of stars was not at rest but was itself in

* Abstract of a Royal Institution discourse delivered on April 28.

motion. Such a movement of the background is now one of the well-established facts of astronomy.

A superficial study of the nearer stars suggests that they are moving at random, with differing speeds and in different directions. But a careful statistical investigation reveals law and order in the motions, not of individual stars but of statistical groups. The motion is best described by the statement that each group of stars (sufficient in number to justify statistical treatment, but also comprised within a sufficiently small volume of space) is describing an orbit about a centre. This centre is the same for all groups, and coincides exactly with the centre of the galaxy, as determined by Shapley from the arrangement of the globular clusters. Those groups which are farthest from the centre move most slowly, just as, in the solar system, those planets which are farthest from the sun move most slowly. The reason is, of course, that each star describes an orbit under the gravitational force of the rest of the stars, just as each planet describes an orbit under the gravitational force of the rest of the solar system.

Detailed statistical study of the stars near the sun shows that, on the average, the orbital speed of a star falls off by 1 km. a second for every 200 light-years increase of distance from the centre of the galaxy. This single datum, which is quite well determined, shows that the sun must take about 250 million years to perform its journey round the centre of the galaxy. Thus it must have completed some ten or a dozen orbits since the earth was born. If the sun is at a distance of 40,000 light-years from the centre of the galaxy, then it must describe its orbit at a speed of about 300 km. a second, a conclusion which agrees well enough with independent estimates made by spectroscopic measurements of the speed of the sun relative to the external galaxies and remote globular clusters.

The various data which have just been mentioned provide the means for weighing the mass which keeps the sun in its orbit, and so the galaxy as a whole. Estimates vary from 110,000 million to 180,000 million times the mass of the sun, so that it seems safe to say that the galaxy contains hundreds of thousands of millions of stars, although the majority are rendered invisible by the thick layer of fog which lies between them and us. It used to be thought that our galaxy was more massive than the others we see in the sky, but this no longer appears to be the case. We are familiar with groups of stars which are held together by their mutual gravitational attractions—the globular clusters provide an instance. There are also clusters of nebulæ which are held together in the same way. It is possible to determine the speeds of motion of the individual nebulæ of a cluster, and so deduce the gravitational forces needed to hold the cluster together. In this way, the average galaxy is found to have a mass of the order of from 100,000 million to 200,000 million suns. Thus there can be no doubt that the external galaxies are at least comparable with our own galaxy in mass.

Finally, it used to be thought that the external galaxies are substantially smaller than our own in size, but it has recently emerged that this too is fallacious. We only see a small part of a galaxy when we study its apparent size on a photographic plate; there is a much larger part beyond, which can only be detected by delicate photometric measurements. When we take this into account, the galaxies still show considerable differences in size, but the majority of the larger prove to be comparable with our own. On the whole, then, our galaxy is simply one of many similar galaxies. Probably about four million such can be seen photographically in the great Mt. Wilson telescope. If we allot 100,000 million stars to each, this makes a total of about $4 \times 10^{17}$ stars—a large number, although still small in comparison with the number of molecules in a cubic centimetre of ordinary air.

# REGIONAL PLANT ECOLOGY IN THE UNITED STATES

By DR. V. J. CHAPMAN
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THE last four years has seen the publication, by J. H. Davis, of three important papers on the vegetation of Southern Florida*. These three valuable papers yield a clear picture of the vegetation and its interrelations with soil types, climate and physiography. The area is especially interesting because climax vegetation is normally related to the climate, but Davis establishes a good case in this area for relating it primarily to the physiography. If the author continues these studies—as one sincerely hopes he will—the vegetation of Southern Florida will be known and understood in very considerable detail. This will be no mean feat for an area of such size. The majority of ecological studies usually refer to relatively restricted areas, and it is refreshing to find a study that embraces such a large region. A broad survey with accompanying detailed studies opens up major problems that would not be so evident in a study of a small area.

In the first paper, on the mangrove vegetation, Davis points out that they are primarily edaphic forests, a conclusion with which I agree, though I would add that there is also a physiographic element involved. Tropical forest of the 'hammock' type is regarded as the climax vegetation, though in the third paper it is also, albeit incorrectly, implied that mangroves represent a climax type. There is no evidence of a transition to brackish or freshwater marsh such as may be found in Jamaica. Davis studied the environmental factors in some detail and he shows that the mangrove species possess a wide tolerance of salinity and grow on at least four types of soil, one of which is a marine peat. I have arrived at similar conclusions from work in Jamaica. Davis relates the mangrove zonation to the height of the surface water, but here one feels that more evidence would be desirable. Some exceedingly interesting information is provided about dispersal. 10,000 Rhizophora seedlings are estimated to float towards the Tortugas every year; this represents only a proportion of the total crop because about 50 per cent of the seedlings from a tree remain embedded in the mud beneath it. The rate of survival at the end of one year is 50 per cent for Rhizophora, 30 per cent for Avicennia and 20 per cent for Laguncularia.

One of the important features of these three papers is the great use made of aerial photography in the study of the communities and the preparation of the

* Davis, J. H., "The Ecology and Geologic Rôles of Mangroves in Florida", Carn. Inst. Wash. Pub., 517 (1940); "The Ecology of the Vegetation and Topography of the Sand Keys of Florida", Carn. Inst. Wash. Pub. 524 (1942); The Natural Features of Southern Florida", State of Florida Dept. of Conservation, Bull. 25 (1943).

vegetation maps. At the present time vast quantities of air photographs of Europe, Africa and elsewhere must be accumulating, and it is to be hoped that they will become available to ecologists, who will then be in a position to study vegetation on a scale comparable to that of Davis.

The second paper, on the sand keys of Florida, is of particular interest because it adds a new set of vegetation maps to the series started by Millspaugh in 1907 and continued by Bowman in 1917. Changes in the vegetation of these keys over a period of thirty-seven years can therefore be studied. The Marquesas, like Jamaica, have few or no living corals, whereas living corals abound in the Tortugas. This is a peculiar feature of the Caribbean and one which greatly needs investigation. Davis concludes that marine currents are the main agents in the formation of these keys; but it is clear also that hurricanes have had a profound influence in the past upon their structure and also their vegetation. Two types of vegetation are recognized, the sea-strand and the mangrove swamp. The use of habitat is employed in the ecological nomenclature. This has been discouraged by most ecologists working in temperate climates, but tropical vegetation, and especially that of maritime regions, appears to have problems of its own. It may eventually prove desirable in such cases to employ a habitat nomenclature. I encountered a similar difficulty in Jamaica. The number of species recorded by Davis is not large; but this is typical of small islands of this type. The climates of the island groups vary sufficiently for the biological life-form spectra to show significant differences. The Schimperian view of 'physiological dryness' is adopted for the mangrove habitat; but the evidence available to-day scarcely supports such an interpretation.

The third paper covers the whole of Southern Florida, and all the various features are considered with a view to future regional utilization and planning. Aeroplanes, cars, special tractors and 'airboats' enabled the author to visit many areas that were previously almost inaccessible. Much of the region is, of course, covered by the famous Everglades. 'Glades' are grasslands flanked by forests, the 'ever' being added to signify that they remain green throughout the year. Much of the Everglades is dominated by the saw-grass, *Mariscus jamaicensis*, but there are also prairies, sloughs and 'hammocks'. These swamps originated as a result of regular seasonal flooding. The 'dismal' swamps with pine and cypress do not form part of the glades. The whole area can be regarded as a huge alkaline peat-bog, in many ways comparable to what the British Fens must have looked like in the past. Vast deposits of peat are here being formed under subtropical conditions. Unfortunately the natural water conditions have been upset and this is bringing about changes in the organic soils and the vegetation. The area is becoming drier and saw-grass is being replaced by bushes (= carr stage of Wicken Fen). The annual transpiration and evaporation from the saw-grass area is often more than the annual rainfall, and hence the water relations are closely bound up with those of Lake Okeechobee. Less water now flows out from this lake than formerly, and this is the main factor responsible for the present changes. Piles of marine shells found inland indicate past ease of travel by innumerable waterways many of which have now silted up. There is evidently scope here for a combination of archæological and botanical research in a manner similar to that so successfully carried out by Godwin and his co-workers in Great Britain.

Ten physiographic regions are recognized for Southern Florida and at least three old shore lines. The sands left by these seas form the main shallow sand soils in which little or no profile has developed. Beneath the Everglades there is an impervious marl layer, and Davis believes that these swamps would never have arisen were it not for this marl layer which effectively impedes drainage. If this is true, then the Everglades are related neither to the present climate nor to existing physiography but to past geological changes. Although twenty soil types are recognized, peats and marls are the outstanding features of this region. The soils are generally shallow and they have been much reduced by fires, which form an important determining factor of the environment. A detailed correlation is made between the different vegetation communities, individual species and the soil types.

A study of the water relations showed that the ratio, time water-logged to time dry, is the most important factor. Because of the low relief a few inches change in elevation makes a profound difference in the drainage relations.

Nine main types of vegetation are recognized and fifteen types are represented on the vegetation map. There is a very high proportion of woody plants, and Davis concludes that at least one half of the area is economically unprofitable and best left in the wild state. The characteristic 'hammock' forests represent the climax vegetation in Southern Florida. These possess a great diversity of plants, many of the species being tropical. If the fire danger were controlled these forests would be larger, while even at present their arrangement provides an indication of the drainage relations. Davis also considers that the cypresses (Taxodium) will not invade an area where water is continually standing on the surface because the seedlings require atmospheric oxygen.

These three papers contain many more valuable observations, but sufficient has been said to indicate their scope and importance.

# BIOLOGY IN WAR-TIME CHINA*

By Dr. PEI-SUNG TANG

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THIS article will be of the nature of a report on the movements of biological institutions during the War and the activities of biologists associated with those institutions. No attempt will be made to survey the entire field of biology in war-time China, or to evaluate the work at present being done by Chinese biologists.

During the decade immediately preceding the War, there were several centres of biological investigation in China from which came a steady output of research. There were, for example, the physiologists at the Peiping Union Medical College, gathered round Robert K. S. Lim†, who virtually founded the science of physiology in China; the biochemists, whom H. Wu brought together in the same College; the Fan

* Condensed version.

† The Romanized names of the biologists mentioned in this article are those used by the authors in their publications.

Memorial Institute of Biology, where H. H. Hu and C. Ping established their School of Systematic Biology; and the Biological Institutes of Academia Sinica and of the Peiping Academy. The extent to which the work of these Institutes has been affected by the War differs greatly in individual cases.

The group led by Robert Lim included such men as H. C. Chang, known for his work on acetylcholine, and T. P. Feng, a pupil of Prof. A. V. Hill, whose review of muscle-nerve physiology appeared in the *Ergebnisse der Physiologie* shortly before the outbreak of war. Around this group was built the Chinese Physiological Society, and to it goes the credit of publishing the *Chinese Journal of Physiology*, perhaps the Chinese journal best known abroad. When war broke out in 1937, Lim was away in Malaya; but he returned to China and offered his services to the Government. In the winter of 1937, shortly before the fall of Nanking, he had but a handful of helpers. From that small start his Medical Relief Corps grew in three years to a sizeable army numbering thousands. This body rendered invaluable service to the fighting troops, not only in China but also in the Burma campaign, for which services Lim was decorated, by both the British and the United States Governments.

Lim is still with the Chinese Expeditionary Forces, serving in the capacity of medical supervisor, but he has now the added responsibility of establishing an Institute of Experimental Medicine for Academia Sinica. Of his former colleagues in Peiping, T. P. Feng has just arrived in Chungking and is temporarily attached to the Shanghai Medical College.

To the best of my knowledge, of the biochemists in H. Wu's department only C. Y. Chang, who is now attached to the Chung Cheng Medical College in Kiangsi, has as yet reached Free China. He was called to that College by Iping Chao, formerly of Tsing Hua University. With them is T. H. Chang, a nerve physiologist, formerly with the Biological Institute of the Science Society of China.

Of the original staff of the Fan Memorial Institute of Biology in Peiping, only its director, H. H. Hu, has reached the interior; this was shortly before the attack on Pearl Harbour. The work of the Institute is now carried out in part by the members of the Yunnan Institute of Economic Botany, established in the early part of the War as a result of Hu's far-sightedness. The Institute continues the survey work started by the Fan Memorial Institute some years ago, paying particular attention to the economic possibilities of plants endemic in the south-western provinces. Also located in Yunnan is the former Botanic Garden of Lushan, directed by the fern specialist, J. C. Ching. Part of the Fan Memorial Institute has moved to Chung Cheng University, in Kiangsi, of which Hu was president for several years.

Shortly after the fall of Nanking, the Biological Institute of the Science Society of China moved from Shanghai to the interior. The director, T. H. Chien, a veteran botanist held in affection by all, suffered great hardship on the long journey from the coast to the interior; but, undaunted, succeeded in moving practically all the equipment and a library of that Institute to a town not far from Chungking, where with a group of faithful colleagues he continues his work on systematic botany. Situated in the same town is the Institute of Zoology and Botany of Academia Sinica, which moved to the interior with its personnel and equipment almost intact during the early years of the War. H. W. Wu, C. C. Wang, C. C. Jao, Sicien Chen, C. C. Teng and others are carrying out research work on freshwater biology, entomology, parasitology, mycology and plant pathology.

Formerly there were four Institutes of Biological Studies in the Peiping Academy, namely the Zoological, Botanical, Physiological and Pharmacological Institutes. Of these the first three moved to Yunnan at the beginning of the War, and the last was left in Shanghai. On the death of Ting-heng Lou, the Zoological Institute was combined with the Physiological Institute, under the direction of Li-ping King. King himself is working on the pharmacology of Chinese herb medicine, while Tchang-si of the same department is conducting extensive surveys of the fishes of Yunnan from the point of view of their economic possibilities. Liou Tchenngo of the Botanical Institute has been making botanical surveys in the south-western parts of China. The director of the Pharmacological Institute, Tzan-Quo Chou, is still in Shanghai.

Also in Shanghai are two other well-known biologists who when last heard of were still engaged on their peace-time researches. One of these is C. Ping, the veteran zoologist who remained behind after the Biological Institute of the Science Society moved to the interior. The other is Tshou-su, who was provided with working facilities in his Institut de Biologie de Shanghai by the British Fund Committee.

C. Tsai has been the moving spirit behind the Medical School of the National Central University, which was transferred to Chengtu shortly after the War began. He has gathered around him a group of young men, including F. Y. Hsu and J. P. Chu, who are working mainly on the anti-hæmolytic action of lecithin and cholesterol. Tsai is now in the United States as one of six university professors invited by the State Department. With Tsai for a time were T. C. Tung and Mrs. Tung, who have now joined the national Tung Chi University in Szechuan and have been able to keep up their work on experimental embryology.

The National University of Chekiang moved to the interior shortly after the War began, first to Kiangsi, then to Kwangsi, and finally to Kweichow. Under the leadership of Sitsan Pai there has arisen one of the most active centres of biological research in war-time China. Apart from Pai, who published two articles on cytogenetics in the first issue of *Science Record*, the department has on its staff C. C. Tan, the geneticist, and T. L. Loo. Burg Tsai, formerly attached to the same department, is now director of the newly established Chinese Institute of Sericulture in the same province. This Institute was opened three years ago and is supported by the British Fund Committee.

The Institute of Psychology of Academia Sinica was moved to Kweilin during the first years of the War. It is situated in a picturesque town not far from the provincial capital, along with the Institutes of Physics and Geology of Academia Sinica. G. H. Wong, the director of the Institute, is continuing his work on physiological psychology, with tadpoles as experimental material. From the city of Kweilin comes news that Amos Kwangchin Penn has discovered in Kwangsi several species of plants which give fairly good yields of rubber and is exploring their industrial possibilities. Penn was formerly connected with the National Tsing Hua University, but

joined the National Kwangsi University after the fall of Hong Kong.

The work of the Physiological Laboratory of the National Wuhan University is in charge of Zangying Gaw, who works on cellular physiology, especially on the growth and metabolism of nitrogen-fixing bacteria. His work is partly supported by the Rockefeller Foundation.

At the National Southwest Associated University are to be found under one roof the National Tsing Hua University, the National University of Peking and the National Nankai University. Here four groups of biologists are engaged in research. In the Department of Biology of the University proper, Sesan Chen, the ecologist, works on the behaviour of ants. In the same Department, under the leadership of C. Y. Chang, head of the Department of Biology of the National University of Peking, a group of young men are working on physiological aspects of plant morphology. Mrs. Chang (*née* C. L. Tsui) is head of the Department of Biology at the nearby National Yunnan University, and continues her embryological studies with a group of young colleagues.

In the same University are the three divisions of the Tsing Hua University Institute of Agricultural Research. The Entomological Division is in charge of C. L. Liu. With him is C. J. Lu, formerly attached to the group of entomologists at Soochow University. Liu is particularly interested in the biological control of insect pests. A wealth of information on this subject has been accumulated and now awaits publication.

The second division of the Tsing Hua University Institute of Agriculture Research is the Division of Plant Pathology headed by the veteran mycologist F. L. Tai. With the able assistance of T. F. Yu, they are accumulating information on the fungi of Yunnan and on the breeding of disease-resistant varieties of crop plants.

My own department, the Physiological Laboratory of Tsing Hua University, is the third division of the Agricultural Institute. It was established in 1938 after the University had moved to Yunnan. It has been my good fortune to invite to my laboratory such able men as H. C. Ying, C. H. Lou, T. Shen and S. C. Pan. Although Ying is now officially on the staff of Peking University, Pan on the staff of the Department of Engineering and Shen in the Department of Biology, common interests and the convenience of sharing our limited resources have kept us together ever since their arrival at the laboratory. The Tsing Hua University Physiological Laboratory is dedicated to research in the broad field of general physiology, attacking certain fundamental physiological processes with the aid of physical and chemical procedures. Ying is engaged in plant hormone research and biochemical aspects of plant physiology. Lou is studying action potentials in plants and is interested in the problems of electro-physiology in general. Pan has been concerned with the industrial applications of micro-organisms, especially with the problem of alcoholic, acetic and lactic fermentations, while Shen's main interest is in the field of nutrition. My own work on cellular respiration still continues. For their work on the physiology of the silk-worm, several members of the laboratory were awarded the Ting Prize of Academia Sinica last year.

Interest in nutrition research is at present sweeping the country like wildfire, and a large number of biologists and biochemists are now engaged on work in this field. The reason for their enthusiasm is twofold. In the first place, existing conditions in the country necessitate the most economical management of our food resources; secondly, nutritional data are much needed for planning agricultural production in the general scheme of post-war reconstruction. Early in 1941 the National Bureau of Public Health called a conference on nutrition in Chungking which has resulted in the mapping out of a comprehensive programme of co-ordinated research in nutrition and food planning for the nation, to be carried out in collaboration with existing centres of investigation. Another result of the conference has been the formation of the Chinese Society of Nutrition, an organization devoted to the advancement of nutrition research in China.

Among the various institutions in which nutrition research is being carried out at the present time may be mentioned the Central University Medical College Department of Biochemistry, where Libin T. Cheng and his colleagues are determining the nutritive values of Chinese foods. At the National Szechuan University C. Y. Chen is doing similar work on certain food products commonly found on the market, such as soya bean flour and preserved eggs. Chen's work is published in his own journal, the *Nutrition Bulletin*, which came into being while he was at the National Peiping Agricultural College. At that time T. Y. Lo was his associate, but at present Lo is conducting a laboratory of his own at the National Chekiang University.

An Army Nutrition Institute has recently been set up at the Army Medical College in Kweichow, with H. Wan as director. The work of the Institute, as its title indicates, is chiefly concerned with nutrition problems in the Chinese Army. A number of publications have already come from that Institute in the form of bulletins and pamphlets, mainly for the benefit of army officers. At about the same time a nutrition laboratory was set up by the National Bureau of Public Health under C. F. Wang. The Institute is chiefly interested in Chinese diets and children's nutrition. As mentioned above, an important part of the work on nutrition at the Tsing Hua University Physiological Laboratory is directed by T. Shen, who has made extensive surveys on nutrition conditions in the Chinese Army and the diets of college students.

An outstanding event in war-time biology in China has been the arrival of Dr. Joseph Needham, of the Cambridge Biochemical Laboratory. Through his extensive visits to many of the centres of biological research he has brought new information and fresh ideas to Chinese workers. He has also helped materially in obtaining chemicals and apparatus, as well as microfilmed literature, through the British Council's Cultural Scientific Office in Chungking. To Dr. Needham and to Dr. John K. Fairbank, of the Office of the Cultural Attaché of the United States Embassy, biological workers in China are indebted for generous assistance.

Almost all the biological journals which were in circulation before the War have temporarily suspended publication because of insufficient facilities and economic pressure. The exceptions are *Sinensia* and the *Chinese Journal of Experimental Biology*, which are making a heroic struggle to appear, albeit irregularly. This accounts for the failure of other journals to reach our friends and libraries abroad. In place of these suspended journals, certain publications in foreign languages (mostly in English) have been brought out as a temporary measure.

These include the *Science Record* of Academia Sinica, which has a section on biology. In addition, there are the *Proceedings* of the Chengtu Branch of the Chinese Physiological Society and the *Biochemical Bulletin* of the Tsing Hua University Physiological Laboratory.

The impression created by this article will perhaps be that practical aspects of biological research predominate in present-day China. This is true to a large extent; but there are still a number of centres where a major part of the work is on academic aspects of biology. This is especially true of the Institute of Psychology of Academia Sinica, and to a certain extent of the Tsing Hua University Physiological Laboratory. The trend towards research of practical value is in fact unavoidable. In the first place the need of the country at the present is certainly on the practical side, and in the second place it is extremely difficult to carry out academic research of real importance under present conditions. Added to these reasons is the desire of every biologist to make himself useful to the country in its war effort. It is therefore not surprising to find biochemists, for example, putting their energy into such problems as army nutrition, the industrial possibilities of certain rubber-producing plants, vegetable oils and fermentation; while most of the systematic biologists have either turned their attention to agricultural problems or undertaken biological surveys of hitherto unexplored country.

# OBITUARIES

## Mr. Emil Hatschek

EMIL HATSCHEK, who died in London on June 4, at the age of seventy-five, carried out pioneer work in many branches of colloid science and did much to direct attention in England to this subject. In spite of the stimulus supplied by the classical researches of Thomas Graham, little was being done in this country on colloids when, in 1911, Hatschek started a systematic course of lectures on colloidal chemistry at the Sir John Cass Institute. This was, I believe, the first regular course on the subject to be given in England, and it continued until 1935, when Hatschek reached the age limit for retirement. From about 1910 until 1932 Hatschek was producing original papers, all marked by elegance and strong individuality, which appeared in various periodicals, including the *Proceedings of the Royal Society*, the *Transactions of the Faraday Society*, *Chemistry and Industry*, the *Biochemical Journal* and the *Transactions of the Institute of Mining and Metallurgy*, apart from the twenty-six or so that appeared in the *Kolloid-Zeitschrift*. These names do something to indicate the width of interest of his work. His services to colloid science were acknowledged when he was made the guest of honour at the Colloid Symposium at Ottawa in 1932, a distinction much appreciated by him. His contribution at Ottawa was a paper on "The Study of Gels by Physical Methods", a subject to which he had devoted much attention.

Hatschek was a Hungarian by birth, but his family migrated to Vienna when he was a child, and it was in that city that he studied at the famous Polytechnicum. Engineering, however, was his subject in those days, and it was as an engineer that he came to England in 1888, at the age of twenty. He became a naturalized British subject in 1900. He concerned himself professionally with matters of chemical engineering, especially filtration, in both England and America: problems that he met in this work first directed his attention to colloid science. About 1910 he retired from active professional work, although he still acted as consultant to certain undertakings, and, possessing private means, devoted most of his time to original experiment.

Hatschek's fancy took him into unusual fields, and in each he found matters of interest and importance. Two curious contributions of his were, one, on the changes in form of spherical segments of elastic gelatine, which on drying formed a gastrula reminiscent of the behaviour of living embryos, and, the other, on the growth of crystals in gels, which had a marked bearing on the growth of minerals. In particular, he showed that with gold the various forms that can be observed when crystals are formed in silica gel closely resemble the natural appearance of gold in quartz. His work on periodic precipitation bore on the banding observed in some natural minerals. He carried out many other elegant and unusual researches, but his greatest body of connected work was on various aspects of viscosity, especially on the anomalous viscosity of many classes of colloids. For this work his wide chemical knowledge, his clear-cut physical conceptions and his good general mathematical powers fitted him admirably. His co-axial cylinder viscometer for investigating the properties of colloidal solutions has been widely used.

In 1913 Hatschek published his "Introduction to the Physics and Chemistry of Colloids", which went into five editions. His "Laboratory Manual of Colloid Chemistry" also achieved wide popularity. In 1928 he produced his "Viscosity of Liquids", a standard work which was at once translated into German. He edited the "Foundations of Colloid Chemistry", a collection of classical papers, and wrote the articles on "Colloids" and "Viscosity" in the last edition of the "Encyclopaedia Britannica".

Hatschek was a man of very wide learning, with a fund of precise information on most matters. He had an excellent knowledge of botany, especially of field botany; he was well versed in the history and theory of music, and was a good pianist; in philology and general history he could hold his own in most companies; and he had a wide knowledge of the literature of England, France and Germany. He was a familiar figure at the Royal Institution and at the Faraday Society, in the government of which he played a prominent part for many years. In 1930 he became a member of the Savage Club, and was there almost daily to his death, acting in an oracular capacity. He never married and, in fact, all his attachments were intellectual rather than emotional. A powerful and original personality, his passing leaves a gap in British science.

E. N. DA C. ANDRADE.

## Dr. Burgess Barnett, M.B.E.

DR. BURGESS BARNETT, superintendent of the Rangoon Zoological Gardens since 1938, died on April 9 at Dooars, Bengal, at the age of fifty-six. He is perhaps best known for his work on the use of snake venom in the treatment of hæmorrhage and epilepsy, mainly carried out while holding the appointment of curator of reptiles of the Zoological Society of London during 1932–37.

He was the son of the late H. F. Barnett of Bescot

Hall, Walsall, and was educated at Marlborough College and St. Bartholomew's Hospital. After the completion of his medical training he took up practice in the Lobitos oilfields of Peru. When the War of 1914–18 broke out he returned to Great Britain and served as a captain R.A.M.C. in France and Macedonia. After the War he returned to Peru, where he continued his study of snakes and supplied many specimens to the London Zoological Society. His appointment as curator of reptiles enabled him to develop his main interest—the study of snake venom and its application in medical practice. His publications relate mostly to this subject, but he also wrote popular articles on natural history and chapters on herpetology.

In 1938 Barnett proceeded to Rangoon, where a new reptile house was being built, so that he could have the opportunity of establishing a snake farm for the collection of venom and making further studies on its medical applications.

During the present War he was awarded the M.B.E. for bravery in Burma, when, as principal medical officer of the Burma-China railway construction unit, he remained behind with refugees during the evacuation through the Chankan Pass, and gave them medical attention on a long march through uninhabited jungle country. E. HINDLE.

WE regret to announce the following deaths:

Mr. E. Bruce Ball, past-president and honorary life member of the Institution of Mechanical Engineers, and an honorary life member of the American Society of Mechanical Engineers, known for his work on hydraulic engineering, on June 17, aged seventy-one.

Prof. A. H. Reginald Buller, F.R.S., emeritus professor of botany in the University of Manitoba, on July 3, aged sixty-nine.

Prof. A. E. Conrady, formerly professor of optical design in the Imperial College of Science and Technology, on June 16, aged seventy-eight.

Dr. J. J. Lonsdale, organizing science master at the Sloane School, Chelsea, during 1914–33, an early worker on ionization by splashing, on June 12, aged seventy-one.

Sir Prafulla Chandra Rây, C.I.E., formerly senior professor of chemistry, University College of Science, Calcutta, on June 16, aged eighty-three.

Mr. George Steiger, formerly chief chemist of the U.S. Geological Survey, on April 18, aged seventy-four; and Dr. Roger C. Wells, who succeeded Mr. G. Steiger as chief chemist of the U.S. Geological Survey, on April 19, aged sixty-six.

# NEWS and VIEWS

## University of Reading: Chair of Agriculture

### Prof. R. Rae

PROF. ROBERT RAE, who has been professor of agriculture in the University of Reading for the past eleven years, has resigned from academic work on his appointment as agricultural attaché to the British Embassy at Washington. During his tenure of office at Reading, Prof. Rae has expended a large amount of time and energy on the expansion of the Department of Agriculture. This work has been highly appreciated by his colleagues and the many students with whom he has come in contact. The acquisition and development of the University Farm at Sonning-on-Thames was entirely due to his efforts. Before his appointment to Reading, Prof. Rae was professor of agriculture in Queen's University, Belfast, and previous to this he had teaching experience at the East Anglian Institute of Agriculture and the Hertfordshire Farm Institute. Many of his friends regret his departure from the sphere of agricultural education. Since the beginning of the War Prof. Rae has served on several agricultural committees connected with greater food production. More than a year ago he went on a lecture tour to the United States, which proved most successful, and where he is recognized as one of the leading authorities on British agriculture.

### Prof. H. G. Sanders

The University of Reading has appointed Dr. H. G. Sanders, fellow of St. John's College, Cambridge, as professor of agriculture, from October 1944. Dr. Sanders was educated at Wellingborough School until 1917 and, after serving for two years in the Army, proceeded to St. John's College, Cambridge, qualifying for the degree of B.A. in 1920. After a period of practical farm work, Dr. Sanders became an assistant in the Animal Husbandry Institute, Schoo of Agriculture, Cambridge. In the winter terms of the sessions 1926–29 he gave courses of lectures in the University of Reading on animal physiology. In 1932 he was appointed a University lecturer in agriculture at Cambridge. In 1940 he was appointed deputy executive officer of the Cambridgeshire War Agricultural Executive Committee, and in 1941 executive officer to the Hertfordshire War Agricultural Executive Committee. Dr. Sander's researches and publications cover a wide range of agricultural problems in both crop husbandry and animal husbandry. His best-known work is "An Outline of British Crop Husbandry", published in 1939.

## Royal Society of South Africa: Marloth Memorial Medal

THE Council of the Royal Society of South Africal has awarded the Marloth Memorial Medal to Dr. J. L. B. Smith, senior lecturer in chemistry in Rhodes University College, and D. Rivett, for a paper on "The Essential Oils of Agothosma". The Marloth Memorial Fund was initiated by the Cape Chemical and Technological Society, and is devoted to the perpetuation of the memory of Dr. Rudolph Marloth, the famous South African chemist and botanist. In 1939 it was handed over to the Royal Society of South Africa for administration. It is awarded in the form of a small payment towards publication of papers of outstanding merit in either chemistry or botany, and a printed medallion heads the paper. The Medal has never been awarded before, but the present paper is considered as of sufficient merit, both from the botanical and from the chemical points of view, to be the first for which this honour is conferred.

## Society for Freedom in Science

FOUR years ago, a circular letter was sent to a few scientific men suggesting the formation of a new society to promote the causes of pure science and of freedom in science. A group of thirty was thus formed, which became the nucleus of the Society for Freedom in Science. The Society has recently issued a statement of its purpose and aims, which are summed up in five propositions; put briefly, these are: (1) increase of knowledge by scientific research and its diffusion have a primary human value; (2) science can only flourish in an atmosphere of freedom; (3) scientific life should be autonomous; (4) conditions of research appointments should give workers freedom to choose their own problems; (5) scientific men in countries not under dictatorial rule should co-operate to maintain freedom of research.

The Society claims a present membership of 134, chiefly as the result of correspondence and the circulation of memoranda; but an effort is now being made to increase this number, so as to have firm backing for the Society's objects. It is feared that with the approaching period of reconstruction those who stress the applications of science to the detriment of so-called pure science and support the view that research should be centrally planned will be allowed undue influence, and the Society hopes to be in a position to insist on the claim for freedom in science. The Society is an informal body, with no rules, no regular subscription and no official president. Its affairs are conducted by a committee consisting of Dr. J. R. Baker, Prof. V. H. Blackman, Mr. R. Brown, Prof. J. A. Crowther, Prof. M. Polanyi, Dr. L. E. Sutton, Prof. A. G. Tansley and Prof. A. E. Trueman; the honorary secretary is Dr. J. R. Baker, University Museum, Oxford, from whom particulars can be obtained.

## Visual Education

MR. G. PATRICK MEREDITH of the Education Department, University College, Exeter, took up the investigation of the use of visual media in education in 1940, and his lectureship was converted in 1941 into a lectureship in visual education—a novel appointment. The work expanded. The accommodation and equipment provided enabled a centre to be established with a staff which now includes an assistant lecturer, Dr. Renée Marcousé. Their researches on the comparative values of different visual teaching techniques were described at a conference held at the centre during July 1–2. One of the most interesting features was the testimony of the teachers who took part in the research. Their enthusiasm for the new media was striking and the demand for new materials and methods was made clear. The following subjects were included in the discussions: the design of the experiment, the statistical techniques and interpretation of the results (including a new technique of analysis); classroom methods, the film and still pictures used, the children's responses; the functions of the museums, exhibitions and other resources; and lastly, the planning of educational film production. The speakers included Mr. G. Patrick Meredith, Dr. Renée Marcousé, Mr. Bernard Gillett, Mr. Edgar Anstey, Mr. Neilson Baxter and the teachers concerned in the research. Representatives of the museums, film industry and Board of Education were present. A detailed report is to be published in the autumn.

## Carnegie Corporation of New York: Annual Report

THE annual report of the Carnegie Corporation of New York, for the year ended September 30, 1943, includes the reports of the president, Mr. W. A. Jessup, and of the secretary and of the treasurer, and gives a complete list of grants voted during the year totalling 2,562,900 dollars. Income for the year was 4,114,952 dollars in the Main Endowment Fund applicable to the United States, and 355,288 dollars in the fund applicable to the British Dominions and Colonies, the interest on the funds being equivalent to 2·7 per cent on investment securities, as compared with a yield of 4·5 per cent in the period 1932–33. The president points out that by means of reserves for various purposes the Corporation has spread allocations for the payment of appropriation for certain long-time interests over a period of years and has built up a depreciation reserve as partial protection of the endowment and legacy. The fact that the income to-day is only three fifths of the income ten years ago has, however, modified the grant-making policy of the Corporation. The Trustees are faced with the necessity of reducing either the number of grants made or the amounts involved, and possibly both.

The president also refers to the growing practice among donors of naming the specific purposes for which money is to be used. A recent inquiry among some twenty institutions showed that less than 10 per cent of the current gifts were free to be administered or allocated by the board of trustees and executive officers of the institutions. The president points out that in many instances a better method would be for the giver to expect the recipient institution to be capable and informed enough, and ready to accept, a larger share of responsibility for determining the allocation of gifts to research, to improvement in teaching, for equipment and for other important purposes within its own organization. Foundations such as the Carnegie Corporation have an obligation to continue to use their freedom from local and regional prejudices and from the pressures to which even privately endowed educational institutions are suffering, to foster new ideas and to nurture the pioneer spirit in education. Speaking of experimental projects, he said that those responsible should not expect support to be continued long after the undertaking has passed the experimental stage. These views are based on a review of the record of academic and foundation experience in administering grants during the past thirty years. During the year 1942–43, 12,000 dollars were voted to the Institute of International Education for continued support of the American University Union in London; grants totalling 225,300 dollars were made to agencies and organizations concerned with international understanding including the Carnegie Endowment for International Peace, the Institute of Pacific Relations and the Ethnogeographic Board under the National Research Council.

## Gas Research Board: Annual Report

THE fourth annual report of the Council of the Gas Research Board has a special importance, covering as it does a period when the Board became associated with the Department of Scientific and Industrial Research. This, however, is only another step in a long course of development extending over nearly half a century, during which the gas industry

has maintained organized co-operative industrial research. Dr. J. G. King, formerly of the Fuel Research Station, has been appointed director, and Dr. F. J. Dent, who has been responsible for a large part of the research activity of the Joint Research Committee of the Gas Research Board and the University of Leeds, has been appointed joint assistant director.

Of the items mentioned, gas technologists will note with interest the progress in the work on the complete gasification of coal. This shows that several lines of work are being followed—direct hydrogenation under pressure, gasification in oxygen and steam under pressure, and catalytic synthesis of hydrocarbons from carbon monoxide and hydrogen. The laboratory work on these themes is in course of transference to large-scale working in plant erected in a provincial gas works. Research on gas purification holds promise of reducing the sulphur content of purified coal gas to one tenth of the figures currently obtained in public supply in Great Britain. Drying by infra-red radiation emitted by gas-heated sources is being studied and apparently offers certain advantages. Methane, a gas of high calorific value, is a principal constituent of coal gas, from which it can be separated by liquefaction to give a portable liquid fuel which in future may be of great service. Gas engineers have always taken great interest in refractory materials, and the present report again reveals this interest. The report may be said to show that the research association under its new style shows already a wide and widening range of activities.

## Terms Used in Telecommunication

THE modern rapid growth of the applications of radio and telecommunications technique makes it desirable, even in war-time, to keep as up to date as possible a collection of definitions of the various terms and phrases used by workers and students in this field. To give effect to this point of view, the British Standards Institution has just issued a revised and enlarged edition of B.S. 204 entitled "Glossary of Terms used in Telecommunication" (obtainable from the British Standards Institution, 28 Victoria Street, London, S.W.1, 2*s*.). This publication has been prepared in collaboration with the General Post Office and other organizations concerned with communications technique and practice. It comprises revised sections of earlier glossaries dealing with telegraphy, telephony, radiocommunication, television and radio direction-finding, together with a new section on fire alarms. An appendix collects together the various symbols used for the quantities defined in the glossary. While it is doubtful if all workers in this field will agree with all the definitions, the revision, collection and rearrangement of the terms in this new publication will be found of considerable use as a reference manual by all those concerned with the preparation of technical documents and publications, as well as by the large number of other scientific and technical workers in this rapidly expanding field of telecommunications.

## Radio-Telegraph Signals

A PAPER on high-speed recording of radio-telegraph signals was read recently in London before the Institution of Electrical Engineers by Messrs. R. B. Armstrong and J. A. Smale, in which the authors first describe the systems in most general use, and then give a brief definition of modulation requirements for telegraph services. The various sources of distortion encountered are fading, noise and interference from other stations, but chiefly phase distortion due to propagation over more than one route between transmitter and receiver. The on-and-off character of Morse signalling enhances the difficulties which come from most sources of distortion. The paper then describes the general characteristics required in radio receivers designed for the purposes under discussion, including a description of two types of receiver in current use. This is followed by a consideration of special requirements of the recording units into which the receivers work, with a description of a typical unit. The special measures provided to offset the three types of distortion previously mentioned are also dealt with.

Diversity reception is discussed, with particular reference to the special problems of combining the automatic gain-control systems and the receiver outputs. Recording by undulator is chiefly considered in the paper as a whole; but the discussion on the effects of distortion, and the counter-measures taken, is even more applicable to machine-printing systems, since the latter have less margins of tolerance in operation. The paper concludes with an indication of the trend of development towards different methods of signalling, which may reduce difficulties of reception and recording in comparison with the old on-and-off methods of conveying intelligence.

## Lighting Reconstruction

THE Illuminating Engineering Society has just issued the first three of a series of Lighting Reconstruction Pamphlets which are planned to be of service to Government departments, local authorities, borough engineers, architects and others who are preparing now for the lighting problems which will confront Great Britain during the period of post-war reconstruction. The present pamphlets relate respectively to "Principles of Good Lighting", "The Lighting of Public Buildings" and "The Lighting of Schools", and they provide excellent summaries of the broad principles of what is needed to make lighting efficient according to the particular application. The pamphlets are obtainable from the Society at 32 Victoria Street, S.W.1, at the uniform price of 1*s*. each, 9*s*. per dozen, or £3 per 100.

## Distilled Water

THE development of the water-still has been slow, the normal type of apparatus being an externally heated metal boiler and a condenser. These are very inefficient, due to the fact that the number of calories required to heat the incoming cold water to boiling point is small compared with the heat required to convert the water into steam, and many kilowatts are required for an output of 20 gallons per hour. There is also the disadvantage of fur deposition from hard water, which can be diminished by taking only a fraction of the rated output.

A new type of still, called the "Strip-Action Still", is announced by Messrs. Townson and Mercer Ltd., 390 Sydenham Road, Croydon, which uses raw steam such as is available in a factory, and is made in units with a capacity of one gallon per hour. The initial design was in heat-resisting glass. The steam passes through an outer jacket which is air-cooled, and deposits dirt and high-boiling liquids with part of the condensed steam. The clean steam then passes down a multi-surface spiral condenser and comes out at the bottom as distilled water. By avoiding much contact with air, the water is of appreciably better

quality in regard to $pH$ value than ordinary distilled water. The inner condenser is water-cooled, and the flow is adjusted so that the distilled water issues nearly at the boiling point.

## Processing Quartz

THE production of a small thin quartz plate from a large crystal weighing several pounds involves a long succession of operations, including repeated cutting, surfacing and checking. Each step requires some form of grinding or lapping, and with the extremely high precisions required and material so hard as quartz, these processes are slow and exacting, although multiple processing reduces the net time per crystal considerably. Until crystals began to be used extensively in electrical work, the grinding of hard brittle substances was limited chiefly to jewels, and the techniques and materials employed were not very well suited to a large-scale processing of quartz. As a result, a considerable amount of research and development was carried out in the Bell Laboratories to discover the most satisfactory methods and to design the most useful machines. An article by W. L. Bond (*Bell Lab. Rec.*, 22, No. 8; April 1944) describes the various lapping and grinding processes employed.

## Accidental Poisoning in the United States

IN the United States, about 1,200 deaths occur each year from accidental poisoning. Analysis of the 355 cases occurring among policy-holders of the Metropolitan Life Insurance Company during 1940–43 (*Statist. Bull.*, 25, No. 2; 1944) reveals the following. More than a quarter of the victims were pre-school children, and among these the commonest poison was strychnine (20 cases), taken in the form of sugar-coated strychnine pills intended for adults, followed closely by oil of wintergreen (17 cases), taken by drinking the pleasant smelling liquid intended for external application. Among the adults the list was headed by overdose of sleeping drugs (72 cases); 49 took poison (commonest were lysol, sodium fluoride) in mistake for medicine; 41 drank methyl alcohol believing it to be a satisfactory substitute for ethyl, and 18 drank poison in mistake for an alcoholic beverage.

## Anti-plague Campaign in Chimborazo

ACCORDING to Dr. C. S. Vera, of Riobamba (*Bol. Of. San. Panamer.*, 22, 875; 1943), a successful anti-plague campaign was carried out in the province of Chimborazo, Ecuador, during August 1, 1942–July 21, 1943. The central office set up in Riobamba directed the activities of the groups organized in each section of the province. 'Cynogas' and flame-throwers were used in destroying rat nests, and a paste of arsenic and phosphorus was used in rat burrows. During the year 43,876 rats were trapped (*rattus* 13,730, *alexandrius* 10,322 and *musculus* 19,815), and almost complete extermination was accomplished in some areas. The spleens of 23,629 rats were examined, but only one (*rattus*) was positive. The incidence of plague in Chimborazo was as follows: 1939, 82 cases; 1940, 40 cases; 1941, 30 cases; 1942, 1 case, and in the first six months of 1943 nil.

## Swedish Town Population

ACCORDING to recent statistics in the *Anglo-Swedish Review* of April, the population of the Swedish capital rose during 1943 by more than 21,000, which is the largest annual increase ever recorded, to 636,000. Greater Stockholm including the suburban districts of the capital now has 800,000 inhabitants, or one eighth of Sweden's entire population. The same increasing tendency is registered for most Swedish towns, 111 out of the country's 123 towns showing rising population figures; Sweden's second town, Gothenburg, has 290,000 inhabitants and the third largest, Malmö, 163,000.

## Summer School in X-Ray Crystallography

A Summer School in X-ray crystallography applied to industrial problems is being held in the University of Cambridge in September along the lines of the school organized last year which proved to be very successful. It is being arranged again by the Departments of Physics and of Mineralogy and Petrology in co-operation with the Board of Extra-mural Studies. In the course, which has been modified as a result of the experience of last year, emphasis will be placed on the interpretation of practical work and on the application of different techniques to various problems. It is particularly designed for scientific workers and technicians who are using the methods of X-ray diffraction in industry and who have had no systematic training in the subject. The Summer School will extend from September 4 to September 16. In view of the present shortage of staff, apparatus and materials, it will be possible to accept only a limited number of people, and application to attend must be made before July 24. Further information can be obtained from the Secretary of the Board of Extra-mural Studies, Stuart House, Mill Lane, Cambridge.

## Announcements

MR. G. D. H. COLE, University reader in economics, Oxford, and director of the Nuffield College Social Reconstruction Survey, has been appointed Chichele professor of social and political theory at Oxford as from October 1.

THE honorary degree of LL.D. has been conferred by the University of St. Andrews on Sir Robert Robinson, Waynflete professor of chemistry in the University of Oxford.

THE honorary degree of LL.D. has been conferred by the University of Aberdeen on Prof. Alexander Findlay, professor of chemistry in the University during 1919–43; Prof. V. M. Goldschmidt, professor of mineralogy and geology, University of Oslo; Sir William Wright Smith, regius professor of botany in the University of Edinburgh.

The degree of D.Sc. has been conferred on Dr. G. A. Cowie, for a thesis on "Study of the Effects of Manures and Rainfall on Yields of Crops grown in Rotation"; J. S. Farquharson for a thesis on "(1) Haboobs and Instability in the Sudan, (2) The Diurnal Variation of Wind over Tropical Africa"; Dr. H. W. Kosterlitz, for a thesis on "Some Observations on the Conversion of Galactose to Glucose in Mammalian Liver and in Yeast". The degree of Ph.D. has been conferred on Charity Waymouth, for a thesis on "An Investigation of Various Substances of Biochemical Importance for Tissue Growth".

MESSRS. H. K. LEWIS AND CO., LTD., 136 Gower Street, London, W.C.1, have been appointed sole distributing agents for the reproductions of German technical books issued by Mr. J. W. Edwards and Edwards Brothers Inc., of Ann Arbor, Michigan. A catalogue of the titles is in preparation. A copy will be sent on request.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Mechanism of Brittle Rupture

THE low strength of brittle materials has been ascribed by A. A. Griffith[1] to the presence of discontinuities which have the properties of small cracks in these materials. Since this theory was published, however, several investigations have established the fact that glass exhibits the phenomenon of delayed rupture to a marked degree, and this is not easily explicable by Griffith's theory alone. The most recent of these investigations, by F. W. Preston[2] in the United States, reports the variation in strength of glass when loads are applied for periods of $10^{-2}$ sec. up to $10^5$ sec., the breaking stress falling from 14·3 kgm./mm.$^2$ for $10^{-2}$ sec. duration of load to 4·47 kgm./mm.$^2$ for $10^5$ sec. duration.

As a result of investigations which will be published shortly, I have been led to the hypothesis that glass consists of an elastic matrix which contains small pockets of 'quasi-viscous' material. These pockets take the place of Griffith's 'flaws'; and when the glass is subjected to a stress the initial load carried by the viscous material is conveyed to the matrix as relaxation of the stress occurs in the viscous material. In this manner a stress concentration grows with time in the matrix surrounding a 'viscous pocket'. Finally, such a pocket would become the equivalent of a hole in the matrix when the viscous material carried no stress.

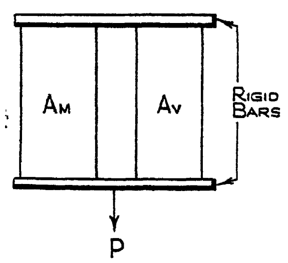


FIG. 1.

To represent the stress concentration occurring in the elastic material surrounding a viscous pocket, I have used the model illustrated in Fig. 1. This is intended to represent *local* conditions at a pocket, and it consists of two cylinders of the same height connected by rigid bars at each end. The area of cross-section of the elastic cylinder is $A_M$, and that of the cylinder of viscous material $A_V$. The sum of these areas is taken as 1, so that when a stress $P$ is applied to the system,

$$S_M A_M + S_V A_V = P,$$

where $S_M$ is the stress in the elastic matrix and $S_V$ the stress in the viscous material. This relation holds at any instant after the application of the load.

Now the *strain* in the two cylinders must always be the same (this means that the strain in the edge of the matrix surrounding a pocket is equal to the strain in the pocket material); and if we designate the strain at any instant as $\sigma$, then the stress in the elastic cylinder is $E\sigma$, where $E$ is Young's modulus.

If the viscous body had a true Newtonian viscosity, the stress-strain-time relationship for it would be

$$S_V t = \eta\sigma, \text{ or } S_V = \frac{\eta\sigma}{t},$$

where $\eta$ is the viscosity.

Hence, at all times,

$$E\sigma A_M + \frac{\eta\sigma}{t} A_V = P.$$

Now if the glass breaks when the strain in the elastic matrix reaches a constant value, say $B$, then the breaking stress, $P_B$, is related to the time of breakage by the expression

$$EBA_M + \frac{\eta B A_V}{t} = P_B,$$

which may be simplified to

$$P_B - a = \frac{b}{t},$$

where $a$ and $b$ are constants.

Hence if log $(P_B - a)$ is plotted against log $t$ a straight line should be obtained, and this has been done with F. W. Preston's results, as shown in Fig. 2. The value of $a$ was determined by plotting values of log $(P - 1)$, log $(P - 2)$, etc., against log $t$; the result being that log $(P - 3)$ yielded the line shown in Fig. 2.

It will be seen that the slope of the line is not unity; in fact $\frac{\delta \log (P_B - 3)}{\delta \log t} = 0{\cdot}126$, so that the equation for the line in Fig. 2 is

$$P_B - 3 = \frac{6{\cdot}3}{t^{0{\cdot}126}}.$$

This indicates that the model may represent the results quite closely if the pocket material is a 'quasi-viscous' substance of the type which G. W. Scott Blair[3] has investigated. Thus it is only necessary to represent the stress-strain-time relationship of the 'viscous' substance as $St^{0{\cdot}126} = \eta^*\sigma$, where $\eta^*$ is a constant. This corresponds with Scott Blair's expression

$$S^\beta t^\varkappa = \psi\sigma$$

in which $\beta = 1$ and $\varkappa = 0{\cdot}12$. These values of $\beta$ and $\varkappa$ would represent a substance of high 'viscosity' approaching the elastic condition, which is not entirely unexpected since the material with which we are dealing is a silicate.

It should be noted that the equation derived from the 'viscous pocket' theory represents the experimental results over a very long range of time, namely, $10^7 : 1$, which may be taken as a very good quantitative support to the theory. It is of special interest that the theory accounts for the difference between ductile and brittle materials as a difference in relations between the elastic and 'viscous' portions. A ductile body may be regarded as one which is constituted of a viscous material with inclusions of elastic pockets, whereas a brittle material is one which is predominantly an elastic substance containing inclusions of viscous pockets. In between these

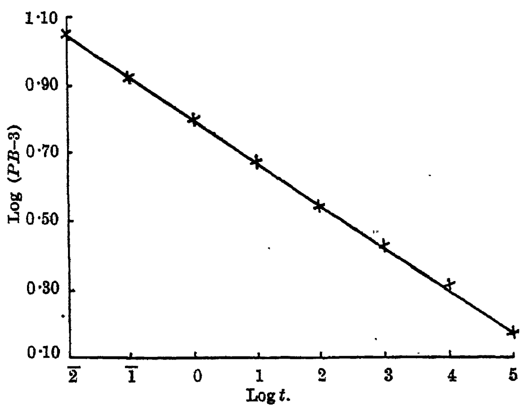


FIG. 2.

extremes there may be bodies which contain both these features to varying extents, and which may therefore be either 'brittle' or 'ductile' according to circumstances of the test.

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[1] Griffith, A. A., *Phil. Trans. Roy. Soc.*, A, **221**, 163 (1920).
[2] Preston, F. W., *J. Appl. Phys.*, **13**, 623 (1942).
[3] Scott Blair, G. W., *Nature*, **152**, 412 (1943).

## Place-Exchange Theory of Plastic Flow, as Applied to Polymers

THE place-exchange theory of plastic flow was originally developed by Becker[1], to account for the flow of metals. More recently a somewhat similar theory has been advanced by Eyring[2] to account for flow in polymeric materials. In the latter theory the flow process is regarded as the movement of a molecule, or segment of a molecule, from one position in the plastic to a neighbouring one, under the influence of thermal energy. If $E$ be the potential barrier separating two positions, and $f$ the stress, then the activation energy for the process is written as $E-bf$, where $b$ is a constant involving the dimensions of the 'unit of flow'. The rate of flow $\theta$ may then be written

$$\theta = \text{const.}\ e^{-(E-bf)/RT} \quad . \quad . \quad . \quad (1)$$

It can be shown from (1) that for very low stresses the system will show Newtonian behaviour, that is, for $bf << RT$, $\theta \propto f$, and Eyring has treated simple liquids along these lines[3]. For $bf > RT$ the following behaviour is predicted

$$\ln \theta = a + b'f \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

(The equations are given in their simplest form.)

We have recently completed an extensive series of measurements on a plasticized cellulose derivative over a stress range 2–160 kgm./cm.$^2$ and temperature range 16–100° C. The methods used were compression of cylinders and extension of rods, care being taken to analyse the total strain into its plastic (non-recoverable) and elastic components. In this note we are concerned solely with the plastic flow.

The important result of our work is that equation 2 is followed only at the lower stresses, that is, up to a certain stress value $f_0$ which is itself a function of temperature. In this range, $f < f_0$, we have further checked, in a qualitative way, the main assumption of the theory; thus we have found that the 'activation energy' for flow falls from *c.* 30 kcal. at 4·6 kgm. cm.$^{-2}$ to *c.* 11 kcal. at $f \geqslant f_0$. For values of the applied stress above $f_0$ we find that the activation energy is independent of stress. In fact, the flow may be described by the equation originally used by Bingham to describe the flow of solid–liquid dispersions through capillary tubes.

$$f \geqslant f_0, \quad \theta = A(f - f_0) \quad . \quad . \quad . \quad . \quad (3)$$

This equation could not have been predicted by the place-exchange theory as it stands. Its application gives hope for a simpler analysis of flow problems in industrial processes than could be achieved by equation 2. We should mention that similar results were obtained by Dillon and Johnston[4] for the extrusion of compounded rubber. Their work, however, by itself, is not directly comparable with ours owing to the presence of 'fillers' in many of their rubbers (that is, they are not dealing with a simple polymer system), and the possibility of 'plug-flow' at the lower stresses. In fact, it might be argued that their rubber-filler systems were analogous to the Bingham solid-liquid paste systems. However, our results would suggest that rubber without fillers may follow equation 3 at high stresses, and there are indications, in the paper quoted, that this may well be so.

It is of interest that we found no indication of a true yield-value, and we may hazard the opinion that in our system, whether or not a yield-value is observed is purely a question of duration of experiment and sensitivity of observation. In fact, it is possible to observe flow in our sensitive extension apparatus at stresses much below the apparent yield-value obtained in our compression plastometer. It is, of course, possible that if the plasticizer content were reduced, a true-yield value would appear. It is of interest that to a reasonable approximation, over a temperature interval of 40° C., the 'mobility constant' $A$ has the same temperature dependence as the intercept $f_0$, namely,

$$A = A_0\, e^{-11000/RT} \qquad f_0 = f_{00}\, e^{11000/RT}.$$

A further feature of our results was that at the very low stresses, in extension, the material showed strain-hardening, $\theta$ falling 20–30 fold over the initial 3–4 per cent extension, reaching an apparently steady value, very similar to the behaviour reported by Andrade for metal wires[5]. At the high stresses used in compression, we could not detect any such behaviour. Whether this was due to instrumental limitations we cannot at present say. It does, however, seem likely that any strain-hardened structure which may be formed initially cannot withstand the large shearing forces produced by the high stresses operative in the compression measurements.

It would seem that a critical attitude is required to the application of place-exchange theories in their present form, not only to the flow of plastics at high stresses, but also to the normal viscosity phenomena in liquids. Granting the application of the theory to plastics at relatively low stresses, it might be surmised that at the higher stresses the flowing molecules may pass over several energy barriers, and that the rate of flow is then determined by the rate of exchange of momentum, as visualized by Van der Waals' and Andrade's theories of liquid viscosity[6]. If this is so, it would argue for the possible application of the momentum exchange theory to the behaviour of simple liquids. It is hoped in the future to make experimental and theoretical investigations of this question.

Approval for publication has been granted by the Director-General of Scientific Research and Development, Ministry of Supply.

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D. C. PEPPER.

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May 12.

[1] Becker, *Phys. Z.*, **26**, 919 (1925).
[2] Tobolsky, Powell and Eyring, "Chemistry of Large Molecules", 125 (Interscience, 1943).
[3] Eyring, *J. Chem. Phys.*, **4**, 283 (1936).
[4] Dillon and Johnston, *Physics*, **4**, 225 (1933). Also Houwink, "Physikalische Eigenschaften und Feinbau von Natur- und Kunstharzen" (Akad. Verlag. Leipzig, 1934).
[5] Andrade, *Proc. Roy. Soc.*, A, **84**, 1 (1910); **90**, 329 (1914); **138**, 348 (1932).
[6] Van der Waals, *Proc. Acad. Amsterdam*, **21**, 743 (1918). Andrade, *Phil. Mag.*, **17**, 497, 705 (1934).

## Displacement of X-Ray Reflexions

A SMALL displacement of the X-ray diffraction maxima from the position determined by Bragg's equation $n\lambda = 2d\sin\theta$ may be caused by experimental conditions, such as the absorption of X-rays in the specimen, or it may be caused by imperfections in the crystal structure, as several authors have shown by theoretical considerations, starting from different assumptions[1,2,3]. It seems, however, that in the latter case no experimental evidence has been produced.

Some years ago, the indexing of the X-ray diffraction pattern of chrysotile caused considerable difficulties, which were ultimately solved by making allowances for a displacement of certain reflexions. In this case, of the thirty-four reflexions observed on the equator and on the second layer line, twenty-two were of the $\{00l\}$ and $\{20l\}$ type (crystal reflected copper $K\alpha$ radiation). These were comparatively sharp reflexions, and the agreement between calculation and measurements was so good as to exclude the possibility of any measurable displacement due to experimental conditions. Still, the remaining third could not be indexed, unless a variable axial length was used for the $b$-axis. Only then could the first layer line also be indexed. Such 'apparent' $b$ values, when plotted against the corresponding index $k$, lie on a smooth curve (Fig. 1), with a few exceptions. These exceptions are, apparently, the reflexions for which the indices $k$ and $l$ are both multiples of three, including zero. Furthermore, all these exceptional reflexions yield the same $b$ value. (More spots have been measured on photographs taken with molybdenum $K\alpha$ radiation, which give a similar picture to Fig. 1, though the measurements are less accurate.)

It is only putting the statement another way round to write that in the X-ray pattern of chrysotile some reflexions are displaced away from the central ordinate in a manner implicitly dependent on the crystal structure. The displacement may be between 0·15 mm. (for 110 reflexion) and 1 mm. (for 190 reflexion), in a camera of 60 mm. diameter, using copper $K\alpha$ radiation.

Quantitatively, the displacement has not yet been fully accounted for. The key to the solution lies in the fact that all the fuzzy spots, and only these, are displaced from the Bragg reflexion position. It is hoped to discuss this matter elsewhere in more detail.

Another interesting error of psychological origin was observed in this connexion. It was found that the distances from the central ordinate of the peaks of the reflexions 020, 110 and 130 on the microphotometer curves are 0·06, 0·05 and 0·11 mm.

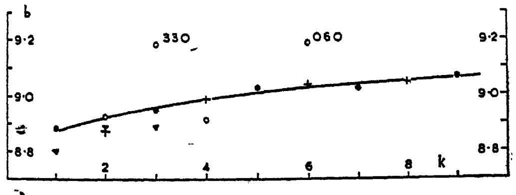


FIG. 1.

Fig. 1. 'APPARENT' LENGTH OF THE $b$-AXIS OF CHRYSOTILE PLOTTED AGAINST THE INDEX $k$. CAMERA 60 MM. IN DIAMETER, COPPER $K$ RADIATION.

O, reflexions $0k0$, on the equator; ●, $1k0$'s on the first layer line; +, $2k0$'s on the second layer line. ▼, microphotometer readings of the 110, 020 and 130 reflexions. Reflexion 040 is a very weak one.

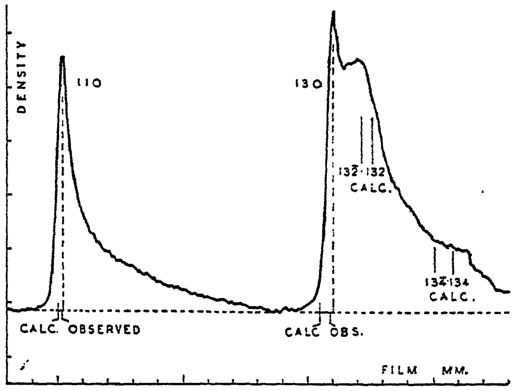


FIG. 2.

Fig. 2. MICROPHOTOMETER CURVE OF THE FIRST LAYER LINE OF CHRYSOTILE.
[$a = 5·32$, $b = 9·2$, and $c = 14·62$ kX., and $\beta = 93·2°$]. Crystal reflected copper $K\alpha$ radiation. The positions of the reflexions as calculated, and as measured by a travelling microscope are also indicated.

respectively larger than the same distances obtained with a travelling microscope. (A difference two or three times larger was obtained from photographs taken with a camera of 19 cm. in diameter for the 020 reflexion.) It seems that in the case of an unsymmetrical density distribution in reflexions such as those measured (Fig. 2), the eye tends to estimate the position of the middle of the line towards the steeper fall of the density. Such an error of judgment will be of importance when measuring unsymmetrical lines, such as partly overlapping reflexions, incompletely resolved $K\alpha$ doublets, or lines of considerable broadening.

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May 11.

[1] Laue, M. v., *Z. Kristallogr.*, A, **82**, 127 (1932).
[2] Landau, L., *Phys. Z. Sowjetunion*, **12**, 579 (1937).
[3] Warren, B. E., *Phys. Rev.*, **59**, 693 (1941).

## Age of the Saline Series in the Salt Range of the Punjab

WITH regard to recent letters on this subject[1], I would recall in addition that Mr. R. V. Anderson reported finding Quercus in the Punjab Saline Series[2]; while Foraminifera said to be from the same were referred by me to Ranikot species. Commenting on my report, Sir Lewis Fermor remarked that: "The discovery of these fossils indicates a Ranikot or post-Ranikot age for the Salt Marl Series, and appears to set at rest the long controversy about the age of the Salt Marl. We appear now to know that the age of this series is Tertiary and not Cambrian"[3].

Mr. Wadia and I had previously referred the Kohat salt to the Eocene[4]; and my later opinion is that all the salt of the region (Kohat and Punjab) is of basal Khirthar age. I have shown[5] that the Kohat-Potwar marine basin was isolated, at the close of Laki times, by a Waziristan ridge on the west, by the initial rise of the Salt Range axis on the south, and by the advance of the Himalayan axis on the north-east. The consequent desiccation of the basin produced Pinfold's 'passage beds' in its north-eastern parts, with salt to south and west;

and the succeeding Lower Chharat (early Khirthar) beds mark a fluviatile interlude before the extensive mid-Eocene transgression brought marine beds (Upper Chharats, Kohat Limestones, etc.) again over that region.

Thus the presence of Tertiary forms in the Punjab Salt Marl proves a Tertiary age for the associated salt, while the stratigraphy of the region more precisely indicates a basal Khirthar age for both the Punjab and the Kohat salt. Prof. Sahni's abundant confirmation of the first point goes far to clinch an increasingly strong case.

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[1] *Nature*, **153**, 462 and 654 (1944).
[2] *Bull. Geol. Soc. Amer.*, **38**, 665 (1927).
[3] *Rec. Geol. Surv. Ind.*, **66**, 117 (1933). Mr. Pinfold and I have since shown that Ranikot beds are well represented on the Salt Range, *vide Nature*, **139**, 414 (1937); *Pal. Indica* (N.S.), **24**, Mem. 1 (1937).
[4] *Trans. Min. Geol. Inst. Ind.*, **24**, 202 (1929); *Rec. Geol. Surv. Ind.*, **65**, 112 (1932).
[5] "Geographical Changes in North-West India during Late Cretaceous and Early Tertiary Times", *Proc. Sixth Pac. Sci. Congress*, 1939, **2**, 483 (1940).

IN a letter dated February 10, one of us directed attention to the discovery of microscopic angiosperm, gymnosperm and insect remains in the Saline Series as exposed in the salt mines at Khewra and Warchha in the Punjab. The situations from which our samples were taken, in the body of a closely bedded series, placed it beyond doubt that the fossils were truly *in situ*; and their affinities make it obvious that the beds cannot possibly be as old as Cambrian.

These fossils were obtained by dissolving two kinds of samples: (*a*) lumps of rock-salt in which thin interbedded layers of saline earth ('kallar') were enclosed, and (*b*) portions of the 'kallar' bands alone, after scraping off the pure salt from both faces. We have now dissolved (*c*) lumps of the massive transparent rock-salt alone, taken from the same spots as before in the two mines. The Warchha salt has revealed shreds of carbonized pitted wood, and thick-walled tracheids with large circular separate bordered pits of the coniferous type. The Khewra salt has yielded, *inter alia*, felt-like masses of fibres of several different kinds; a fragment of wood with pitted cells; a cuticle recalling that of grasses, with a beautifully preserved stoma in an epidermis of elongated cells; and the chitinous coat of a small arthropod with paired jointed legs and traces of mouth parts.

Thus the rock-salt itself seems to be as rich in organic remains as the interbedded laminæ of saline earth. The indications are that the entire salt- and -'kallar' series in these mines is teeming with microfossils. For anyone now to claim that these fossils are 'derived' would be to claim that the whole series, even in the depths of these mines, has been churned up with extraneous matter. We cannot, of course, say whether the fossils reported by others were truly *in situ*. Ours certainly are; and although their exact age-value still needs to be critically assessed, there can obviously be no question of an age as ancient as Cambrian. On present evidence the only alternative seems to be that the Salt Marl is Tertiary.

B. SAHNI.
B. S. TRIVEDI.

Department of Botany and Geology,
University, Lucknow. April 19.

## Preparation of a Stable and Active Pancreatin from Commercial Samples

THE problem of a pancreas protease preparation of a constant activity can be solved by the following preparative process:

1 gm. of the commercial sample of 'Pancreatin' (Parke, Davis and Co.) is mixed with 10 ml. distilled water and kept under toluene for about 24 hours at 37°. The mixture is then centrifuged, filtered and 50 ml. absolute alcohol are added. The centrifuged precipitate obtained may be washed with ether and is dried in a vacuum desiccator over sulphuric acid.

The yield of the dried substance is about 10 per cent of the original commercial product. It dissolves easily in water and is about five times as active as the original water extract (casein as substrate).

The preparation retains also the lipase (of weak activity) and the amylase of the mother substance.

While the water extracts or even the generally used glycerol extracts are not stable and their activity diminishes gradually on standing, even when kept under toluene (water extracts) in an ice box, the dry preparation seems to retain its original activity indefinitely.

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March 3.

## A Basic Principle Governing the Changes in Organisms under the Action of External Factors

THE present communication describes a general method of making a quantitative estimation of the response to external factors shown by biological systems of different order (individuals, taxonomic categories, populations or communities).

In studying the effect of training and learning, psychologists were the first to raise the question concerning the relationship of a change in the character to its original value[1]. In my recent work published in collaboration with my associate Dr. Gause[2] we gave three examples of "a negative relation between acquired and inherent characters of the organism".

My method consists in calculating the regression coefficients of positive or negative increments ($\Delta x$) of the character on their original values ($x$), both variables being expressed in the original units of measurement.

Four types of such a regression under the influence of an external factor can be established:

TABLE 1.

| Change in size of character | Relation of increase $\Delta x$ to character | Type |
|---|---|---|
| Increase | Positive correlation | I |
| | Negative ,, | II |
| Decrease | Negative ,, | III |
| | Positive ,, | IV |

The crossing of the $x$ axis by the regression line determines the point where $\Delta x$ is equal to 0. This

point is located at a distance $A$ from the origin of the co-ordinate system. $A$ represents the asymptotic value of our character or a lower or upper limit of its expression (see below). The coefficient of regression $b$ gives a measure of increments per unit of the character. It may be used in two ways: first, in ascertaining the efficiency of different factors acting upon a series of several groups of test animals, and secondly in comparing the response of different animal groups to the influence of the same factor, which shows the reactability of each particular group. Table 1 contains the constants $b$ and $A$ calculated for different examples taken from several branches of biology, medicine and agriculture. These constants were calculated from regression lines fitted by hand to observation points plotted on millimetre paper.

What is the mechanism of such types of biological reactions? The most plausible explanation seems to consist in the assumption that individuals or taxonomic groups used in experiments represent different stages of positive or negative growth. Thus, the most common type of exponential growth can be expressed by a function $x = A(1 - e^{-Ct})$. The differential equation of such a function, $\frac{dx}{dt} = CA - Cx$, clearly shows the velocity of growth to be inversely proportional to the size of the character $x$. The negative coefficient of regression in our type II is just an approximation of the function connecting the velocity with the size of the character obtained by using $\frac{\Delta x}{\Delta t}$ instead of $\frac{dx}{dt}$. Other types can be derived in the manner described from corresponding exponential growth-curves or curves of decay. In cases when growth of decay approaches an asymptote a kind of friction seems to take place. This friction is produced by components of the system which surround the character under question. Our types II and IV represent cases with an internal friction of components, while types I and III involve systems with a self-accelerating plus or minus growth.

TABLE 2.

| Name of the organism of the system | Character studied | Factor | $b$ | $A$ | Type |
|---|---|---|---|---|---|
| *Epilachna chrisomelina* (beetle)[3] | Diffuse black pigment between spots | Temperature | +1·5 | — | I |
| Children[4] | % hæmoglobin in blood | Honey diet during two weeks | −0·7 | 6·4 | II |
| Men affected by tertian malaria[5] | Spleen size (cm.) | Acrichine + chinoline therapy | +0·2 | 6·33 | IV |
| Black and white race and sexes[6] | Expectation of life at birth | Secular changes, 1901–20 | −0·13 | 54·4 | II |
| Man[7] | % correct answers obtained with the aid of tachistoscope | 3 days training | −1·0 | 87 | II |
| Patients[8] | Mitogenic radiation of blood | Hydrotherapy at a summer resort "Tzaltubo" | −0·54 | 32·5 | II |
| Populations of different countries[9] | Birth-rate per 100,000 | Secular changes, 1871–1913 | +0·40 | 170 | IV |
| Population of different States of U.S.A.[10] | Vital index | Secular changes, 1919–21 | +0·24 | 20 | I |
| Different soil types[11] | Oat yield (centners per hectare) | Fertilizer | −1·00 | 255 | II |

A general principle of a quantitative response of elements in biological systems (and very likely in physical also) to external factors may be expressed as follows:

($A$) Positive changes (increments) in a character are: (I) directly proportional to its original values, if the growth of the character is not limited by an upper asymptote; in such a system the component is exposed to a stimulatory action of adjacent components; and (II) inversely proportional to its original values if the character is limited by an upper asymptote; in such a system the component is exposed to the inhibitory action of adjacent components.

($B$) Negative changes (decrements) in character are: (III) inversely proportional to its original values, if its changes are not limited by a lower asymptote; in such a system the character is exposed to a stimulative action of other components; and (IV) directly proportional to its original values, if the character is limited by a lower asymptote; in such a system the character is exposed to an inhibitory action of adjacent components.

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[1] Kincaid, M., *Psych. Rev.*, **32** (1925).
[2] Gause, G. F., and Alpatov, W. W., *C.R. Acad Sci. U.S.S.R.*, **30**, No. 3 (1941).
[3] Timofeef-Ressovsky, H. A., *Biol. Z.*, **61**, H.1/2 (1941).
[4] Root, A. J., "ABC and XYZ of Bee Culture" (1940).
[5] Raskin, A. J., *Med. Parasit. Parasit. Dis.*, **8**, No. 6 (1939).
[6] Pearl, R., in Nelson Loose Leaf "System of Public Health—Preventive Medicine" (1927).
[7] Isserlin, M., "Handbuch der Naturwiss.", **10** (1935).
[8] Rikkel, A. V., *Arch. Sci. biol.*, **35**, *B*, No. 1 (1934).
[9] Pearl, R., "Medical Biometry" (3rd edit., 1940).
[10] Pearl, R., "Studies in Human Biology" (Baltimore, 1924).
[11] Kirssanoff, A., "Mitcherlich's Theory" (Moscow, 1930).

## Densities of the Embryonic Stages of Sea-Urchins

RECENTLY the densities of the early stages in the development of the very common sea-urchin, *Psammechinus miliaris* (Gmelin), have been obtained by the displacement method. The figures are as follows:

| | Temperature | Density |
|---|---|---|
| Ova | 9·8 °C. | 1·0725 |
| Zygotes (1 hr.) | 10·4 | 1·07360 |
| Blastula (embryos, 14 hr.) | 11·0 | 1·07582 |
| Blastula (larvæ, 20 hr.) | 9·8 | 1·0793 |
| Gastrula (late, 44 hr.) | 9·8 | 1·08390 |
| Echinopluteus (early, 68 hr.) | 9·8 | 1·09626 |

Both ova and zygotes were left in large dishes of sea-water for an hour. The densities of the ova and zygotes have been twice confirmed, and similar figures were obtained for the ova and zygotes of *Echinus esculentus* L.

In *P. miliaris* there is therefore a definite and gradual increase in density; but the figure which is

of outstanding importance is that for the zygote, which exceeds that of the ovum in spite of the inclusion of a large amount of liquid of a lower density.

Within an hour of fertilization taking place the zygote 'puts out' the very familiar fertilization membrane, which is separated from what was the original ovum by a clear space containing a colourless liquid. Measurement has shown that while the diameter of the original ovum is practically unchanged, the diameter of the whole zygote, including the membrane, is considerably increased, with the result that the volume of the zygote is more than twice that of the ovum. In the past, there has been a great diversity of opinion as to the nature both of the fertilization membrane and of the liquid enclosed. From simple basic reasoning we should expect the enclosed liquid to be slightly hypertonic to sea-water and to have a similar density. The density of the Plymouth sea-water at 11·0° C. was 1·02663, and the density of the enclosed liquid could therefore scarcely exceed 1·03. Hence, taking the density of the ovum as 1·07 and that of the surrounding liquid as 1·03, we should expect the density of the whole zygote to be 1·05, or very nearly so, instead of which it is 1·0736. When, therefore, the ova are left in sea-water, there is a very definite increase in density; and it would seem that this increase can only be attributed to a great intake of calcium ions, which on reaching the cell proper, immediately begin to separate out as cryptocrystalline granules of calcite. Calcium ions would not cause any appreciable increase in density, but calcite granules would, since their density is 2·7.

Much remains to be done, but unfortunately it is too late in the season to undertake it now. We know that spicules of calcite occur in the blastula larva stage. They are definitely crystalline, and in the first stages are intracellular and cannot have come into existence suddenly. This is clearly indicated, apart from anything else, by the gradual increase in density. The recrystallization of calcite from very finely divided granules of calcium carbonate is a well-known but none the less a complicated process even when it takes place in simple inorganic solutions. The protein in the echinoderm cell would probably act as a protective colloid and complicate matters considerably. It is known that calcium ions play a most important part in the early embryology of echinoderms, and also that the presence of excess of lithium ions prevents the normal development of echinoderms, especially in the earliest stages.

This is far too big a problem to discuss here, but the fact remains that while freshly precipitated calcium carbonate recrystallizes normally from sea-water, or from a solution of sodium chloride of the same strength, it does not crystallize normally from a solution in which the sodium is replaced by lithium.

The above concept of the great intake of calcium is strongly supported by the work of Ephrussi and Rapkine, as recorded by Needham[1], on the ash of the echinoderm egg. The figures are as follows:

| Hours after fertilization | | 0 | 12 | 40 (Pluteus) |
|---|---|---|---|---|
| Total ash, % dry weight | .. | 1·5 | 9·1 | 16·8 |
| Total ash, % wet weight | .. | 0·34 | 2·06 | 3·56 |

There are, of course, slight variations in the densities and also in the volumes of ova and zygotes, but in all cases investigated so far the density of the latter exceeds that of the former, which is the really important point.

In a previous communication[2], I recorded the fact that a ripe ovum in the oviduct of *Calanus finmarchicus* may increase its volume nearly twenty-two times within a few hours of extrusion. I also pointed out that in certain cases such volume changes took place irrespective of syngamy. Clearly in all these cases a consideration of *density* must preclude the assumption that these great changes in volume can be due to an intake of water alone.

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[1] "Chemical Embryology" (Camb. Univ. Press), 1271.
[2] Lowndes, A. G., *Proc. Zoo. Soc. London*, A, **113**, 28 (1943).

## Composition of Coal

DETAILED research into the composition of coal demonstrates its intricacy. There can be no true understanding of this complicated and important substance if the results of research are confused by the use in varying senses of descriptive terms.

A recrudescence of confusion has recently arisen around the use of the word 'anthraxylon' as though it were synonymous with 'vitrain'. In their book "Geology in the Service of Man", Prof. W. G. Fearnsides and Dr. O. M. B. Bulman say (p. 108) "black, shining, bright coal ('vitrain' or 'anthraxylon') also composed of woody fragments". This is misleading: 'vitrain' and 'anthraxylon' are not equivalent, and 'vitrain' may or may not be composed of woody fragments.

I originally demonstrated and defined 'vitrain' in 1919[1]; in the following year Dr. Thiessen[2] described 'anthraxylon' as being layers which "correspond to the larger pieces of woody peat". Following my paper of 1935[3], an international agreement about coal terminology was achieved at the congress at Heerlen in the autumn of the same year[4].

It is particularly unfortunate at the present time when coal research is receiving wider recognition that confusion should be exacerbated, so that one must state emphatically that the term 'anthraxylon' cannot be used as the equivalent of 'vitrain'.

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[1] Stopes, M. C., *Proc. Roy. Soc.*, B, **90**, 469 (1919).
[2] Thiessen, R., *Bull.* 117, U.S. Bureau Mines, Washington (1920).
[3] Stopes, M. C., *Fuel*, **14** (1935).
[4] Jongmans, W. J., Agreed details of "Nomenclature of Coal Petrography", *Compt. Rend. Congres Heerlen*, Sept. 1935 (Maestricht, 1938).

## Factors in the Production of Honey

I MUST apologize for having misquoted Miss Betts in my article in *Nature* of May 13. Her optimum figure for maximum sugar intake is 56 per cent, not 40, and incidentally is nearly independent of temperature. My conclusion is not affected. It is interesting to note that for a given concentration she established that the sugar intake is roughly doubled between 15° C. and 25° C. and follows roughly a linear law over a wider temperature range. The optimum concentration is nearly independent of temperature.

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# HARDENING AND DARKENING OF THE INSECT CUTICLE

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IT has long been known that the darkening of the insect cuticle which often follows ecdysis or metamorphosis is due to enzyme action. Tyrosinase has often been shown to be present in the body, and Bhagvat and Richter[1] have found in certain soft cuticles an active polyphenol oxidase. The chromogens involved, 'dopa' and related dihydroxyphenols, have been identified in a number of insects[2,3], and it has been suggested[4] that they play an active part in hardening the cuticle, by providing on oxidation ortho-quinones which 'tan' the protein constituents by the introduction of aromatic cross-linkages.

Considerable information on this subject is therefore available, but its integration into a coherent account is still largely incomplete. In particular, the functional connexion between the secretion of the pupation hormone and the changes in the cuticle is obscure. A recent morphological and histochemical study of the larval and pupal cuticles of *Sarcophaga falculata* (Dipt.) has, however, produced significant results.

The soft cuticle of the mature larva consists of an outermost very thin resistant epicuticle, covering a thicker ($4\mu$) layer of protein unassociated with chitin which may be termed the secondary epicuticle. Beneath these lies the endocuticle, a laminated chitin-protein complex of two distinct layers. The outer, laid down early in larval life, possesses pore-canals[5], but the inner, added later, when the chitinization of the cytoplasmic filaments of the canals is complete, has none.

The secondary epicuticle carries an oxidase, readily demonstrated by the 'Nadi' reagent, which is capable under experimental conditions of oxidizing catechol and 'dopa' rapidly, and tyrosine much more slowly. It is inhibited by cyanide, but not by sodium azide, and is resistant to drying and to treatment with alcohol, acetone, and chloroform. Moreover, at pupation the outer layer of the endocuticle gives a positive reaction to the ferric chloride test for orthodihydroxyphenols. Darkening of the cuticle begins at the epicuticle, where enzyme and substrate meet, and spreads inwards through the outer endocuticle, which is thereby converted into the hard and dark exocuticle of the puparium. The inner layer of the endocuticle does not darken, one reason for this being that it lacks the necessary phenol.

The accumulation of a dihydroxyphenol in the outer endocuticle coincides with the appearance in the blood of a similar phenol. That this phenol is not produced by tyrosinase activity after withdrawal of the blood for test is clearly shown by subjecting early pupæ to hydrogen cyanide vapour before opening, and withdrawing the blood into a small quantity of dilute hydrogen cyanide. Blood so obtained darkens on exposure, and gives faint but positive reactions to tests for dihydroxyphenols. The source of the phenol seems reasonably to be found in the oxidation *in situ* of the blood tyrosine by tyrosinase.

Larval blood, when tested at intervals with Millon's or Mörner's reagents, shows a progressive increase in its tyrosine content from the cessation of feeding to the onset of pupation, and thereafter shows a decline, and this is confirmed by the results given by a quantitative examination of the blood carried out by Dr. G. Fraenkel before this work was begun (private communication). It may be postulated that the decline in tyrosine content at pupation indicates its consumption as the blood phenol is produced and removed by oxidation in the cuticle.

Although tyrosinase is known to occur in insect blood, its source has not been shown. Drawn blood and dissected larvæ have therefore been examined after treatment with the 'Nadi' reagent, cytochrome oxidase having been inhibited by methyl alcohol. A positive reaction to this treatment, apart from that given more feebly by the secondary epicuticle, is given only by a small number of hæmocytes which closely resemble the œnocytoids described by Wigglesworth[6]. In addition to occurring free in the hæmolymph, they are found also in small clusters adhering to other tissues between the main posterior spiracular trunks. First noticeable in larvæ which are ceasing to feed, they increase in number as the crop is emptied, disappearing again shortly before pupation. On the addition of catechol to the blood, they rapidly darken; and in blood which is allowed to stand they darken more slowly. It seems clear that they are centres of tyrosinase synthesis. In freshly drawn blood the œnocytoids give a positive 'Nadi' reaction only after treatment with methyl alcohol—a feature which will be discussed later.

In late larval life, therefore, both tyrosine and tyrosinase are present in the blood, which darkens on exposure but not *in situ*. The reason for the inability of the blood to darken within the body seems due to the reducing properties of the hæmolymph. Kuwana[7] has distinguished clearly between a stable reducing fraction of the blood of silkworms, due to uric acid and glucose, and an unstable fraction, which increases greatly before ecdysis and pupation, falling sharply as these changes proceed. The unstable fraction decreases on exposure of the blood. In the present work the unstable fraction is provisionally regarded as being stabilized *in situ* by the action of an unidentified dehydrogenase, a view supported by the fact that the blood of late Sarcophaga larvæ will reduce tolylene blue almost completely, and phenol-indo-2 : 6-dibromophenol completely. Allowing the blood to stand, or treating it with methyl alcohol or chloroform, however, causes full return of colour to the dye solution. The same treatment greatly accelerates the darkening of exposed blood, due possibly to destruction of dehydrogenase and release of tyrosinase activity. In agreement with these observations, Graubard[8] obtained a higher effective tyrosinase yield from Drosophila larvæ after treatment with chloroform water.

Tyrosinase activity in the blood, prior to pupation, may therefore provisionally be regarded as being held in check by the reducing power of a dehydrogenase, tyrosine being reduced as rapidly as it is oxidized. This is further indicated by the inability of the œnocytoids to give an immediate 'Nadi' reaction without previous alcohol treatment, and by the darkening, first pointed out to me by Dr. G. Fraenkel, which is caused in intact larvæ by immersion for 24 hours or more in methyl alcohol. Larvæ which are ceasing to feed darken slightly at each end, and older larvæ and young pupæ blacken completely. On the other hand, young larvæ undergo no change, and isolated pieces of cuticle are not darkened under the same conditions. Similar results

are given, but more slowly, owing perhaps to slower penetration, by solutions of phenyl-urethane, phenyl-urea, and other narcotics known to inhibit dehydrogenases. Sections reveal that this induced darkening proceeds inwards from the epicuticle and closely simulates the natural process, although unaccompanied by normal hardening. Clearly a phenol, derived from the blood, is oxidized by the polyphenol oxidase of the epicuticle.

The significance of the increase in the unstable reducing fraction of the blood before pupation noted by Kuwana may therefore be explained by the simultaneous accumulation of tyrosine and tyrosinase, although the meaning of the increase before ecdysis, which is followed in the silkworm by cuticle growth but no darkening, is less clear. However, the speculation is inevitable that one effect of the liberation of a pupation hormone may be to modify the reducing properties of the blood by dehydrogenase inhibition, so leading to the release of tyrosinase activity, the production of a polyphenol, and the ultimate hardening and darkening of the cuticle.

A full account of this work, together with observations on the structure and growth of the cuticle, will be published in due course.

[1] Bhagvat and Richter, *Biochem. J.*, **32**, 1397 (1938).
[2] Schmalfuss and Müller, *Biochem. Z.*, **183**, 362 (1927).
[3] Schmalfuss, Heider and Winkelmann, *Biochem. Z.*, **257**, 188 (1933).
[4] Prior, *Proc. Roy. Soc.*, B, **128**, 393 (1940).
[5] Dennell, *Nature*, **152**, 50 (1943).
[6] Wigglesworth, "The Principles of Insect Physiology" (London, 1939).
[7] Kuwana, *Jap. J. Zool.*, **7**, 273 (1937).
[8] Graubard, *J. Genetics*, **27**, 199 (1933).

## CHARCOAL BRIQUETTES AS LOCOMOTIVE FUEL

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A. F. JOSEPH and B. W. Whitfield[1] described in 1921 the production of charcoal briquettes made from Sudan woods. They used as binder gum arabic or sorghum flour, both of which are available locally. Such briquettes are satisfactory for firing a stationary boiler, but are quite unsuitable as locomotive fuel. For this use 20–25 per cent volatile matter is needed; furthermore, the briquettes have to withstand the severe conditions within the locomotive fire-box where, if the briquettes are weakly bound, forced draught and shaking may cause loss of fuel and where high temperature may produce clinker. On the instructions of Dr. J. D. Tothill, director of agriculture and forests, Sudan Government, work was resumed with the war-time object of finding a locally produced substitute for coal needed by the Sudan railways.

The previous workers had used a falling weight to compress their material. Lacking normal briquetting equipment we devised a hand-operated drop stamp mounted on wooden baulks. This drop stamp produces briquettes 7 in. × 6 in. × 3 in. at a rate exceeding one ton per working day, and enabled us to prepare the rather large amounts needed for full-scale locomotive fuel trials.

Pitch (Mexphalte *D.H.* 75/85) was incorporated with the charcoal (1 : 9 parts) and is considered essential. We had no means of steam-heating the mix as in normal briquetting practice, and therefore added gum arabic as primary binder. Ground charcoal and pitch, well mixed with water and gum solution, was stamped into briquettes by three impacts from a 75 lb. weight having 6 ft. fall. The freshly made briquettes can be handled with care and, in this hot climate, harden on drying to withstand crushing loads up to 2,000 lb. per sq. in. Strongest briquettes are obtained from a mixture containing about 60 parts water to 100 parts dry matter. Strength also depends upon a number of other factors, notably gum content, number of impacts, method of grinding, etc.

Charcoals available in the central Sudan are made from three kinds of acacia: *A. arabica* Wild., ash content 3–5 per cent; *A. seyal* Del., ash content 5–11 per cent; *A. mellifera* Benth., ash content 6–15 per cent; *A. arabica* Wild., which forms riverside forests within the 400–600 mm. rainfall belt, is of value as rough timber and also as fuel. *A. seyal* Del. is a prominent member of the thorn grassland association found on moderately alkaline clay soils receiving summer rainfall of about 600 mm. This acacia produces a marketable gum, but is otherwise useless, since when cut it is severely attacked by boring beetles (Sinoxylon spp., Bostrychidæ). The shrub-like *A. mellifera* Benth. is of use only as a source of charcoal. It is found in almost pure stands on clay soils receiving about 500 mm. summer rainfall. The charcoal used in Trials 3 and 8 (see below) was reputed to be mainly *A. seyal* Del., which is perhaps the most promising source. A consignment of *A. mellifera* Benth. charcoal was briquetted and burned in Trials 5, 6 and 7, the failure of which was due to causes not associated with the variety of charcoal used. The charcoal used in Trials 9, 10 and 11 was a well-mixed consignment believed to consist for the most part of *A. arabica* Wild. Reliable comparison of these three charcoals as constituents of locomotive fuel is not yet available, since other factors enter into the trial data. As another possible source of supply, some cotton-stalk charcoal was prepared, but owing to its high ash content (17 per cent) and low density was considered unsuitable as locomotive fuel.

It is extremely difficult to reproduce on a small scale conditions inside the fire-box of a locomotive steaming with full load. For this reason, the full-scale trial is the only valid test of a proposed coal substitute. Data obtained in such trials by inspectors of the Sudan Railways are tabulated below.

A locomotive with a 200-ton load steamed fairly well with charcoal-pitch briquettes made as described above, but it was seen that more volatile matter was needed. This was provided by dipping the air-dry briquettes in furnace fuel-oil. The mechanical strength of the briquettes is somewhat reduced by dipping in oil, but their resistance to rain is notably enhanced. In this way considerable quantities were made conforming fairly closely to the following percentage composition: charcoal, 75; pitch, 8; oil, 8; gum, 4; water (lost at 105° C.), 4. Of these constituents water is the most variable, since the charcoal absorbs 2–8 per cent water at relative humidities of 20–80 per cent. Oil content decreases with time, owing to slow volatilization.

Briquettes of this type were used in a number of full-scale fuel trials using Prairie type locomotives of 33·1 sq. ft. grate area. The accompanying table gives details of successful runs which were made with service trains running to schedule at the moderate speeds customary in the Sudan. Normal

steam pressures (170–175 lb. per sq. in.) were maintained except in Trial 11.

| Trial | Load (tons) | Run (km.) | Running time (hr. | min.) | Av. steam pressure (lb./sq. in.) | Fuel used (kgm.) | Equiv. evap. | Cal. value (B.T.U.) |
|---|---|---|---|---|---|---|---|---|
| 3 | 753 | 313 | 7 | 14 | 175 | 4970 | 8·06 | 12830 |
| 8 | 539 | 313 | 6 | 54 | 170 | 4920 | 7·33 | 12140 |
| 9 | 750 | 266 | 6 | 02 | 175 | 6037 | 6·17 | 13690 |
| 10 | 733 | 313 | 7 | 12 | 175 | 5611 | 6·88 | 13220 |
| 11 | 634 | 313 | 7 | 48 | 160 | 6580* | 7·23* | mixed fuel |

Representative figures for 'equiv. evap.' of coals under conditions of these trials are: Welsh or American coal, 9·4; South African, 8·7; Indian, 8·2.

In all these trials the charcoal was ground in edge-runner mills. For material used in Trials 3 and 8, the following is a specimen sieve analysis.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Less than | | 8 | 16 | 30 | 60 | 100 | 200 | I.M.M. |
| Greater than | 8 | 16 | 30 | 60 | 100 | 200 | | I.M.M. |
| | 15 | 15 | 12 | 16 | 9 | 13 | 19 | per cent |

Coarser material (less than $\frac{5}{8}$ in.) was used in Trials 9 and 11, while that used in Trial 10 was intermediate (less than $\frac{1}{4}$ in.). The trial results fell off accordingly, Trial 9 being inferior to Trial 10, which is inferior to Trials 3 and 8. With these coarser materials it was observed that a larger proportion of fuel was carried away unburned and accumulated in the smoke-box. In Trial 11 we remedied this by burning the briquettes in 50/50 mixture with an American coal, but this and other similar trials were unsatisfactory for, although no data are available as to the performance of the American coal used in Trial 11, if the average figure of 9·4 for equiv. evap. is taken, it indicates that the briquettes were burned inefficiently. The failure of such trials is due to troublesome clinker formation caused, it is thought[2], by admixture of the siliceous ash of the coal with the basic ash of the charcoal. A similar formation of clinker occurs with charcoal-pitch briquettes to which 5 per cent of siliceous fine soil has been added.

Owing to the large demand for pitch for various war purposes, we tried to do without this constituent. The briquettes, however, disintegrated in use and gave poor results (equiv. evap. 5·08 and 4·62 in Trials 5 and 7). These failures occurred although the briquettes, which had been given a higher proportion of oil, resembled the successful ones in calorific value (12310 B.T.U.) and ash content (about 10 per cent). Considerable quantities of briquettes rejected owing to mechanical weakness, damage by rain, etc., were remade and satisfactorily disposed of in shunting engines or used to fire a stationary boiler, for which purpose they roughly equalled coal.

It became clear at an early stage of our work that the grinding of charcoal to a suitable powder was the most difficult part of the whole process. The product obtained from edge-runner mills is satisfactory, but much difficulty was experienced with charcoal pulverized in beater type mills which continually produced weak or badly cracked briquettes. Internal strains are gradually released when charcoal is moistened, and we have some reason to think that this difference in behaviour depends in part on the fact that charcoal was moistened before being fed to edge-runner mills but was fed dry to beater type mills. Neither sieve analysis nor microscopical examination of the fine particles revealed any notable feature other than the rather less rounded shape of particles obtained from a beater type mill.

One satisfactory full-scale trial was carried out using briquettes made from charcoal which was wetted and then crushed by an ordinary garden roller and stirred by rakes to prevent packing of the fragments into a resistant bed. In this trial the briquettes were burned in 50/50 mixture with American coal, some steam pressure being lost owing to formation of clinker. (Trial 12. Load 777 tons; run 313 km.; running time 9 hr. 34 min.; av. steam pressure 150 lb./sq. in.; fuel used 4,938 kgm.; equiv. evap. 8·26.) Since edge-runner mills were not available for production of briquettes on a larger scale, we have devised a type of bull-drawn roller in which twin rollers are set at an angle so as to combine the shearing and crushing action such as occurs in an edge-runner mill. Strong, mechanically sound briquettes have been consistently produced by this simple means.

The experiments described above were carried out in 1942 and concluded the first part of our inquiry. We have since been filling in the gaps with a long series of fairly obvious multi-factor experiments of which the results will be published later. In 1943 some 1,000 tons of charcoal-pitch briquettes were produced, under the direction of Mr. J. Smith, chief conservator of forests, in a first attempt to use the process on a larger scale, but the briquettes disintegrated when used in main-line locomotives and had to be burned in less severe conditions. With extemporized equipment, unskilled labour and limited supervision it is difficult to turn out large amounts of a good and uniform product. Charcoal burning is now being increased, and a small briquetting factory, embodying normal industrial equipment, is in operation. In this a mixture of charcoal (85 parts) and Mexphalte *DH* 75/85 (15 parts) is steam-heated and pressed between rollers, gum and oil being omitted. The product is strong and waterproof and does not disintegrate in the fire-box. Owing to formation of clinker, however, locomotive fuel trial results have been poor (equiv. evap. 5·08, 4·95). This difficulty probably arose from use of dirty charcoal and therefore should soon be eliminated or reduced.

Our thanks are due to the General Manager, Sudan Railways, for help in the well-equipped Atbara workshops and for the skilled and willing co-operation of his staff. We are also indebted to Dr. A. J. Henry, Government analyst, for determinations of calorific value.

[1] Joseph, A. W., and Whitfield, B. W., *J. Soc. Chem. Ind.*, 15, 190 (1921).
[2] Searle, A. B., "Refractory Materials" (C. Griffin and Co., Ltd., 1917), 48.

# RESEARCH PROGRAMME FOR SOUTH WALES

IN an inaugural address to the South Wales Institute of Engineers at Cardiff on January 20, on "Industrial Planning and Research: Catchwords or Realities?", Dr. F. J. North emphasized that our plans for the expansion of industry and for the betterment of social conditions will be useless unless the availability of the means for giving effect to them has been assured. What is technically possible is not necessarily economically profitable; the success of a venture depends on a market as well as upon raw materials, and the value of one industry is related to its effect upon others. The single-track approach to many of our problems, Dr. North said, is largely due to the gap which exists between scientific knowledge and popular comprehension of it, a gap which will only be permanently bridged when a new attitude towards science is adopted by those responsible for

the educational system of Great Britain. Discussing particular proposals such as coal and its hydrogenation, the Severn Barrage scheme and the like as contributions to Welsh reconstruction, he pointed out that such questions cannot be considered solely in terms of regional standards or local expediency. The first step in giving effect to plans for social betterment in all its aspects is to make the nation realize the extent to which its welfare depends upon coal, upon those who make it available for use, and upon those who attempt to discover how best to use it.

After reviewing the position of coal in the economic picture, Dr. North discussed the aims and objects of research. He deprecated the distinction between fundamental and industrial research as helpful neither to science nor to industry, and emphasized that research is a continuous process in which one step prepares the way for another. In the past, largely because of the abundance of the world's natural wealth to which Great Britain has access, industry in general prospered without much recourse to the results of research, but now as a nation we have to recognize the desirability of doing willingly in peace-time some of the things we are doing under compulsion in war-time. The only way to ensure a future adequacy of research is to create conditions affecting remuneration, prestige and equipment, in which research will be an attractive career, while those concerned with the commercial side of industry must be encouraged to develop a scientific outlook which will enable them better to appreciate and to respond to changes in the availability of raw materials, in public taste, and in technical possibilities. Dr. North urged that the right line of advance is to extend the existing facilities by more generous appropriations to the Department of Scientific and Industrial Research, more generous grants to the universities and more generous support from firms and industries that have not yet accepted their full share of the burden. Closer collaboration between research organizations is also required, and while there are in South Wales all the necessary elements for concerted research in the interest of local industry, there are few signs of general co-ordination. He believes that regional commissioners for the co-ordination of research might help those concerned in the industries of such a well-defined area to know what has been done or is contemplated, and at the same time keep the appropriate government department aware of the collective needs of the area.

In regard to a research programme for South Wales, Dr. North considers that a prime necessity is the vigorous prosecution of the survey of the chemical and physical properties of all the coal seams, and the completion of the geological re-survey of the coal-field. The chemical information would indicate the nature and distribution of the various kinds of coal present, and the geological survey would indicate where and under what conditions they can be mined. Given a fair idea of the trend of industrial development, it would be possible to pay special attention to mining methods appropriate to the kinds of coal likely to be in greatest demand, and to the size and degree of purity of the coal. Co-ordinated work of this kind would help the mines to meet the increasingly exacting demands of industry; but mining research should also be encouraged to indicate the coals which can be most safely and cheaply won, leaving to industry the onus of finding efficient ways of using them. Knowledge of the varieties of coal and their potentialities must be the basis of any attempt to explore the possibilities of the underground gasification of coal, as well as of decisions concerning the kinds of new industry that can be developed and the localities in which they should be founded. Such decisions, in turn, afford guidance to those concerned in determining the position and character of new housing schemes, the facilities for access to them and the amenities required. Again, South Wales cannot afford to be unconcerned at the general lack of official interest in geological exploration, since its industries require minerals and ores not locally available.

Dr. North suggested that the basic principles should be to develop industries in which there is the greatest possible difference between the value of the raw materials used and that of the commodity or article produced, and in which the largest possible part of that difference is represented by payments to those whose services have effected the difference. Scientific and technical workers must be the guides and not the tools of the politician and financier, and the industries selected for foundation or expansion should be those which can be self-supporting at least within a reasonably short time. We should think along the lines of organic evolution, in which there is a continual reaction to changing environment by organisms which possess, in some degree, the capacity to modify or control it. An important function of the South Wales Institute of Engineers is to help create public awareness in matters appertaining to the industrial future of the region.

## INDUSTRIAL FATIGUE AND ABSENTEEISM

THE Industrial Health Research Board has issued a pamphlet (London: H.M. Stationery Office. 3*d*.) giving a survey in non-technical language of the problems of absence from work and prevention of fatigue. Merely vague statements about the excessive amount of absenteeism are valueless. It is necessary to know how much there is, to what extent it is greater than in peace-time and the conditions leading to it.

The Industrial Health Research Board has been studying the problem throughout the war years in numbers of factories of varying size and kind, and the records have been analysed. In normal times, it was usually estimated that absence should not exceed five per cent of the possible hours of work a year. During the war years, this amount has increased and is now between six and eight per cent for men and between ten and fifteen per cent for women. There are considerable variations from factory to factory. Factories of recent growth, situated far from the homes of those who work in them, employing women unused to factory work, show an absence-rate almost twice as high as some of the old-established works within easy travelling distance of the workers' homes.

In most factories it was found that the women lost about twice as much time as the men, and married women lost up to three times as much as single women. The conditions conducive to absence include excessive hours of work, bad working conditions, unexplained idle time, wages problems, lack of co-operation between managers and workers. The factory, however, is not the whole environment of the worker; conditions outside the factory also play a part. Some of these refer to transport difficulties,

shopping, housework and children, as well as the presence on leave of husband or son. There must also be considered the less obvious but important conditions that affect the body and the mind of the individual worker; for example, boredom, lack of understanding of the value of his work, anxiety, ill-health. As much care should be taken of the health of the industrial worker as is taken of the health of the men and women in the Fighting Forces.

The accumulated effects of war-time conditions have caused in many workers a state vaguely labelled industrial fatigue, of which one expression is in absenteeism.

During a war it is impossible to avoid making heavy demands on people's energy; but it should have been possible, if adequate use had been made of the available knowledge, to have prevented some of the worst effects. Unfortunately, for diagnostic purposes the effects of fatigue and those of boredom are similar, namely, lowered output, inferior quality of work, increase of accidents, discontent, and some physical symptoms of ill-health. Fatigue and boredom also affect one's attitude to the work and to the War. The over-tired or very bored worker becomes despondent or indifferent, and tends to lose his sense of proportion in regard to himself and his surroundings, as well as to the course of the War. The remedies are not really difficult to deduce or to make effective.

The weekly hours should not exceed 60 for men and 55 for women, and even these are too high for certain classes of work. The week-end break is important. There should be adequate rest pauses within each spell of work. Attention should be given to the design and speed of machines, and to the selection and training of people for the jobs they are best fitted to undertake. Good working conditions including canteens, and rest and recreation rooms, help to decrease fatigue and boredom, and music is a very popular antidote.

The pamphlet is most attractively printed, produced and illustrated.

## NATURAL HISTORY OF THE MINNOW

Miss Winifred Frost has done good work on the biology and natural history of the minnow *Phoxinus phoxinus* (*J. Animal Ecol.*, **12**, No. 2; Nov. 1943). Taking Lake Windermere and one of its affluent streams, the River Brathay, as headquarters, the minnow has been studied in detail for two years. The investigation deals with its habits, growth, food and reproduction. Minnows are active and pelagic in both lake and stream from April until October, and migrate into deeper water where they are relatively passive and hidden under stones from November to March. They breed from May until July, sexual maturity in a few being reached at the end of the first year: the majority of those in their second year and all older fish are mature.

Length frequency curves supported by scale examination indicate that there are certainly three-year classes, and suggest the possibility of a fourth. The feeding habits have been studied intensively and it is found that in the lake, although a variety of food is taken, planktonic Crustacea, particularly Cladocera, form the chief food and these are also much eaten by the other fish. The supply of these organisms is, however, so large that it seems unlikely that the minnow is a serious competitor for food in this community, especially because of its inshore habits. In the river, Algæ are eaten, a much larger proportion of insect larvæ and less Cladocera and copepods. Much of the food here is similar to that of the young brown trout, and competition is likely. As to enemies, there are many, for the minnow is eaten by a few trout and many perch but not much by the pike. Eels also eat it and it forms part of the diet of the brown trout.

In Windermere and similar large lakes the conclusion is that it is unlikely that the minnow is a serious competitor for food, and it is of itself an appreciable source of food for larger fish. In running water inhabited primarily by salmon and trout the possibility of serious competition is great. So far as fishery conservation is concerned it is concluded that in general, provided the fish population is balanced with active predators to keep their numbers in check, it may be said that minnows are not inimical to a fishery. If, however, the balance is disturbed in favour of fish such as salmon and trout to the exclusion of the more active predatory fish, the minnow may multiply and become a menace.

## JUTE STUDIES

Recently there have been several Indian publications upon the anatomy of jute (*Corchorus*) with special reference to the fibre production and development. Such studies are to be welcomed as affording a basis for the practical improvement of varieties and for modification of extraction and preparation methods.

An earlier paper by Prof. B. C. Kundu (*J. Indian Bot. Soc.*, **21**, 93; 1942) has been followed by Agricultural Research Memoir No. 1 from the Indian Central Jute Committee. This confirms the work of Kundu in the main particulars, though the authors, S. S. Ghosh, K. R. Rao and J. S. Patel do not agree that the original protophloem of jute is secondary in origin. Discrepancies here may be associated with the age of the shoot apex examined; certainly Kundu's figures of the early procambial strands are striking in their demonstration of the early growth being entirely by longitudinal divisions, though it may not necessarily be solely with radial seriation as in the case of cambial activity.

In *C. capsularis* these authors record the presence of a distinct periderm, not seen by Kundu, much of whose material was grown under greenhouse conditions in England; the authors note how this periderm, as also the free development of adventitious roots at the base of plants frequently flooded during growth, may prove a deleterious influence upon the ready separation of the fibre during retting.

As Agricultural Research Memoir No. 2, Messrs. J. S. Patel and S. S. Ghosh have published a preliminary study of the anatomy of retted jute. These studies have shown how progressive the isolation of the fibre strands may be; thus they may be free in the top portion of the stem in five-six days, in the middle of the stem in nine-twelve days and at the base only after fifteen-twenty days. Heavily lignified fibres resist retting, while near nodes, injuries, etc., retting is usually delayed (this was exemplified, in the case of nodes, in some photographs communicated by J. H. Priestley to the late Dr. S. G. Barker, *J. Textile Inst.*, **30**, 273; 1939). These retting studies contain some preliminary notes on retting organisms; but these need extension by isolation and culture of the organisms by the usual methods.

# FORTHCOMING EVENTS

## Thursday, July 6—Sunday, July 9

BRITISH RHEOLOGISTS' CLUB (at St. Hilda's College, Oxford).—Conference.

**Friday, July 7**

10 a.m.—"Rheology of Large Deformations and Plastic Flow", (*a*) Plasticity of Metals; (*b*) Polymers; (*c*) The Liquid State.

2.15 p.m.—"Relations between Shear, Tension and Compression in Complex Bodies (The pi-problem)".

5 p.m.—"Some Rheological Applications to Medical Science".

**Saturday, July 8**

10 a.m.—"Rheological Nomenclature and Symbols Metallurgical and Non-Metallurgical".

8.30 p.m.—"Future Organisation of Rheology".

## Tuesday, July 11

QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Exhibition of specimens and discussion.

## Thursday, July 13

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the LONDON SECTION and the INSTITUTE OF METALS) (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 7.30 p.m.

## Friday, July 14

SOCIETY OF CHEMICAL INDUSTRY (at the Royal Institution, Albemarle Street, London, W.1).—Sixty-third Annual Meeting. At 11.30 a.m.—Presidential Address. At 2.45 p.m.—Prof. A. V. Hill, F.R.S.: Messel Medal Address.

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. J. Proudman, F.R.S.: "The Tides of the Atlantic Ocean" (George Darwin Lecture).

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER or LECTURER IN PHYSIOLOGY—The Secretary, King's College, Strand, London, W.C.2 (July 11).

MISTRESS or MASTER to teach MATHEMATICS in the Junior Technical School of the Selby Art School and Technical Institute—The Secretary to the Managers, Education Office, Garforth, near Leeds (July 11).

CITY ELECTRICAL ENGINEER AND MANAGER of the Carlisle Electricity Undertaking—The Town Clerk, Town Hall, Carlisle (July 12).

ASSISTANT MASTER to teach ENGINEERING DRAWING, ENGINEERING SCIENCE, and WORKSHOP TECHNOLOGY up to the standard of the Ordinary National Certificate in Mechanical Engineering, in the Redditch Technical School—Mr. G. Brodrick, Education Office, Church Green West, Redditch (July 12).

DEPUTY BOROUGH ENGINEER AND SURVEYOR AND DEPUTY PLANNING OFFICER—The Borough Engineer and Surveyor, Town Hall, Barking, Essex (July 13).

ASSISTANT MASTER (temporary) to teach SCIENCE SUBJECTS, principally CHEMISTRY and MECHANICS, in the Junior Technical School—The Director of Education, City Education Offices, 33 St. David's Hill, Exeter (July 14).

ASSISTANT VETERINARY INVESTIGATION OFFICER at the University of Bristol Agricultural Advisory Centre—The Secretary and Registrar, The University, Bristol (July 14).

ELECTRICAL ENGINEER (temporary)—The Clerk to the East Grinstead Urban District Council, Norton House, London Road, East Grinstead, Sussex (endorsed 'Temporary Electrical Engineer') (July 14).

BURSAR to the Queen's College, Oxford—The Provost, Queen's College, Oxford (July 15).

SPEECH THERAPIST—The Director of Education, Shire Hall, Nottingham (July 15).

ASSISTANT LECTURER AND DEMONSTRATOR (woman) IN ZOOLOGY—The Principal, Royal Holloway College, Englefield Green, Surrey (July 15).

MAN or WOMAN to teach GEOGRAPHY and ELEMENTARY MATHEMATICS in the Mexborough Schofield Technical College—Mr. E. B. Stockdale, Education Office, Mexborough, Yorks. (July 15).

LECTURER (temporary) IN MINING, a LECTURER (temporary) IN MINERAL DRESSING, and a LECTURER (temporary) IN ENGINEERING—The Professor of Mining, Royal School of Mines, Prince Consort Road, London, S.W.7 (July 15).

LECTURER IN GEOGRAPHY—The Principal, Borough Road College, Isleworth, Middlesex (July 17).

DEMONSTRATOR (man or woman) in the Department of Inorganic and Physical Chemistry—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (July 17).

GRADUATE or equivalent in MECHANICAL and/or ELECTRICAL ENGINEERING, and a GRADUATE IN SCIENCE to teach Science in Lower Forms, together with some General Subjects, in the Bridgend Mining and Technical Institute—The Director of Education, County Hall, Cardiff (July 17).

MASTER or MISTRESS (temporary, full-time) to teach MATHEMATICS and SCIENCE to Junior Technical students, ARITHMETIC to Junior Commercial students, and SCIENCE to Catering students in the Harrogate Technical Institute—Mr. W. E. C. Jalland, Secretary to the Managers, Municipal Offices, Harrogate (July 17).

ENGINEER to the Eden Catchment Board—The Acting Clerk to the Eden Catchment Board, The Courts, Carlisle (July 19).

GRADUATE LECTURER IN ELECTRICAL ENGINEERING at the Lincoln Technical College—The Director of Education, City Education Office, 4 Lindum Road, Lincoln (July 19).

DIRECTOR OF THE OTAGO SCHOOL OF MINES (University of Otago)—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (July 21).

LECTURER IN EXPERIMENTAL PHYSIOLOGY—The Registrar, The University, Sheffield (July 28).

JOHN RANKIN CHAIR OF GEOGRAPHY—The Registrar, The University, Liverpool (July 31).

W. H. COLLINS PROFESSORSHIP OF HUMAN AND COMPARATIVE PATHOLOGY—The Secretary, Royal College of Surgeons of England, Lincoln's Inn Fields, London, W.C.2 (July 31).

SENIOR LECTURESHIP IN THE DEPARTMENT OF METALLURGY of the University of the Witwatersrand—Dr. W. Cullen, 4 Broad Street Place, London, E.C.2 (July 31).

FOREST ENGINEER for the Sierra Leone Government Forestry Department—The Secretary, Overseas Manpower Committee, Ministry of Labour and National Service, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. 1114).

DAIRY CHEMIST (University Honours Graduate, with Bacteriology training)—The Technical Office, Milk Marketing Board, Thames Ditton, Surrey.

LECTURER (woman) IN EDUCATIONAL PSYCHOLOGY—The Principal, St. Katharine's College (Liverpool), at Queen's Hotel, Keswick, Cumberland.

GRADUATE ASSISTANTS (two) qualified to teach MATHEMATICS, SCIENCE and ENGINEERING DRAWING in the Junior Technical School and National Certificate classes, at the Ashton-under-Lyne Technical School—The Director of Education, 8 Warrington Street, Ashton-under-Lyne, Lancs.

MASTER or MISTRESS for MATHEMATICS, and a MASTER for ENGINEERING SUBJECTS—The Principal, Erith Technical College, Belvedere, Kent.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

Post-War Development in Radio Engineering, Part 1. Pp. 16. (London: British Institution of Radio Engineers.) [136

Natural Lighting: General Considerations for those concerned with Lighting Problems of Reconstruction. (Lighting Reconstruction Pamphlet, No. 4.) Pp. 12. (London: Illuminating Engineering Society.) 1*s*. [136

Souvenir of the Columbus Quincentenary Exhibition. Being a Descriptive Guide to the Exhibition of Rare Books relating to America, opened in the Wigan Library, May 30, 1944, by Dr. Richard Heindel. Compiled by Arthur J. Hawkes. Pp. 12. (Wigan: Public Library.) 2*d*. [136

British Rubber Producers' Research Association. Publication No. 45: The Statistical Length of Rubber Molecules. By L. R. G. Treloar. Pp. 8. (London: British Rubber Producers' Research Association.) [136

Imperial Bureau of Plant Breeding and Genetics. Bibliography on Insect Pest Resistance in Plants (with a Supplement on Resistance to Nematodes). Pp. 40. (Cambridge: School of Agriculture.) 1*s*. 6*d*. [136

## Other Countries

Educational Yearbook of the International Institute of Teachers College, Columbia University, 1943. Edited by Prof. I. L. Kandel. Pp. xi+297. (New York: Teachers College, Columbia University.) 3.70 dollars. [86

Punjab Irrigation Research Committee. Report for the Year ending April 1941. Pp. vii+234. (Lahore: Government Printing Office.) [86

Imperial College of Tropical Agriculture. Report of the Governing Body and the Principal's Report to December 31st, 1943, and the Accounts for the Year ended August 31st, 1943. Pp. 24. (Trinidad and London: Imperial College of Tropical Agriculture.) [136

Carnegie Institution of Washington. Year Book No. 42, July 1, 1942–June 30, 1943; with Administrative Reports through December 7, 1943. Pp. xxxii+208. (Washington, D.C.: Carnegie Institution.) [136

Bulletin of the American Museum of Natural History. Vol. 82, Art. 7: New England Annelida, Part 2, including the Unpublished Plates by Verrill with Reconstructed Captions. By Olga Hartman. Pp. 327–344+plates 45–60. (New York: American Museum of Natural History.) [136

University of California Publications in American Archeology and Ethnology. Vol. 35, No. 10: Observations on the Yurok; Childhood and World Image. By Erik Homburger Erikson. Pp. vi+257–302. 50 cents. Vol. 39, No. 3: Concerning the Middle Chimú Style. By Jorge C. Muelle. Pp. 203–222+plates 6–7. 35 cents. Vol. 40, No. 1: Studies in Plains Indian Folklore. By Robert H. Lowie. Pp. 28. 35 cents. Vol. 40, No. 2: Notes on Pomo Ethnogeography. By Omer C. Stewart. Pp. 29–62. 35 cents. Vol. 40, No. 3: Washo-Northern Paiute Peyotism; a Study in Acculturation. By Omer C. Stewart. Pp. vi+63–142+plates 1–2. 1 dollar. (Berkeley and Los Angeles, Calif.: University of California Press; London: Cambridge University Press.) [136

## Catalogues

Books and Prints relating to Mexico, South America, Central America, the West Indies, Bermuda, the Antarctic, with a Selection of Old Atlases and Maps. (Catalogue No. 671.) Pp. 58. (London: Francis Edwards, Ltd.)

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CONTENTS




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## RESEARCH AND COLONIAL DEVELOPMENT

GIVEN a sufficiently detached perspective of the inception and trend of British Colonial development, one might well form an impression not differing greatly from that proceeding from a survey of the workings of human nature. There would be disclosed to one's view such elements as curiosity, adventure, courage, need, opportunism, foolishness, erratic behaviour, much remissness, and unwise discontinuity of effort ; but there would also be evident a real tenacity of purpose, a growing element of perception and constructiveness, together with a willingness to recognize past mistakes, and, not least, a determination to make good in the future. Those who are familiar with almost any one of our Colonies will be able to fill in the details of the mixed and not always laudable historical scene.

Whatever a review of the past may disclose, the keynote to the future is evident. In almost every Colony there is much to be done. The general problem of Colonial improvement is not a simple one : in each territory, according to its particular character, there are to-day many matters requiring more or less simultaneous consideration ; and the same holds good for these territories taken collectively. So the clamour for action arises on all sides. As obviously everything cannot be begun at once, those responsible for the administration of programmes of research and for welfare schemes have to face the questions : How to begin, and where ? A partial answer to these questions is given in two official documents just issued*.

In the First Annual Report of the Colonial Research Committee, some of the research schemes already approved are set out, together with a general survey of the fields that await attention. These last include topographical and geodetic surveys, geological research, fisheries, agriculture, animal health and forestry, medical research, the social sciences, industrial and archæological research. Not least, the important consideration of creating a cadre of men of science versed in Colonial problems is already being implemented by the institution of twenty-five Colonial research fellowships. This wide casting of the net and generous appreciation of what should be attempted through the medium of research towards the welfare and advancement of the Colonial Empire, at a period when the war effort is rising to its climax, is surely to be commended. Not only are these activities in our best administrative tradition, but coming at this particular time they should also do more than almost anything else to indicate to the outside world something of the essential national attitude to our overseas possessions.

It is true that these matters are for the most part still at the exploratory stage. But while any undue delay is to be deplored, the launching of new and

* Colonial Research Committee; First Annual Report 1943–44. (Cmd. 6535.) (London: H.M. Stationery Office, 1944.)
Colonial Development and Welfare Act, 1940. Return of Schemes made under the Colonial Development and Welfare Act, 1940, by the Secretary of State for the Colonies with the Concurrence of the Treasury in the Period from 1st April 1943 to 31st March 1944. (Cmd. 6532.) (London: H.M. Stationery Office, 1944.)

costly ventures without sufficient initial consideration would be not less harmful. Broadly speaking, the Committee has been concerned with two main aspects: first, with a review of the various fields of research together with a consideration of the central, regional and local organization required to deal with them; and secondly, with a scrutiny of specific schemes submitted for consideration.

In reviewing the general position, the Committee has been impressed with the need for providing, for each main branch of science, a co-ordinating centre to which proposals for research in that branch can be referred for expert scrutiny. "The Committee have therefore favoured the establishment of specialist Research Committees or Councils, which, in addition to being available for the provision of advice to the Secretary of State, would be in a position to be in direct communication with individuals, institutions or teams at work in the Colonies and so help break down the isolation noted in the Progress Report as a disadvantage suffered by Colonial research workers in the past."

As to the preparation of research programmes and decisions on priorities, the Committee has had to deal with the initial question of the distribution of responsibility and function between "the centre and the field, between London and Colonial Governments". It is recognized that no simple or uniform answer is possible. The various research councils and the Committee will serve in a purely advisory capacity to the Secretary of State: any authority in particular matters, such as the administration of a particular scheme, would be delegated by the Secretary of State or with his concurrence by some Colonial Government. The regional organization of research —a desirable feature—is also under consideration.

To those who rightly cherish and uphold the essential quality of freedom in science, the emphasis on planning and on the centralized scrutiny of research projects may perhaps raise doubts as to the general outlook. This issue is dealt with as follows: "The Committee feel bound to point out that whereas, rightly handled, regional organizations of this nature hold out excellent promise for good work and for a harmonious co-operation between workers in the field and the organizations which are being built up at the centre, it might also be possible by wrong organization to impede the flow of research which is the object of all. In their opinion, the conditions of success for the fruitful application of research to Colonial needs lie in the achievement and maintenance of a due balance between the greatest possible freedom of activity on the part of the research workers themselves, whether as individuals or as teams, and the proper allocation of the available resources of all kinds to the solution of the most urgent problems."

This attitude, if it can be maintained in practice, would appear to be sound. In all these anticipated developments one thing stands out clearly—the importance, at all levels, of securing the best men for particular jobs. This is recognized by the Committee. Whatever decisions may be reached as to the relations between central and regional organizations, between administrator and research worker, "the arrangements should be such as to attract and retain the services of research workers of adequate calibre. To this end, such workers should not feel that by working in and for the Colonies they are in any danger of falling behind the progress of their sciences, or of losing their chances of advancement therein. They should be able to maintain the freest possible contact with the advancement of science and with such institutions as exist, or may be created, for the co-ordination and dissemination of new knowledge. Furthermore, these workers must not be inhibited from working in the way best calculated to allow them to achieve the most valuable results, which means, in the field of scientific research as much as in any other sphere of creative activity, allowing the worker the greatest possible latitude as to his methods of work. Complete freedom of enquiry is not the only, but it is an essential, condition of fruitful research work." This aim of recruiting men of real talent, and of giving them freedom, scope, and reassurance as to the future, should be the subject of the widest publicity in all the universities and other educational institutions of Great Britain. Given such men, imbued with the ideal of service, we may look with confidence to a future fruitful in results.

The Report rightly directs attention to the part which local peoples may play in planning and guiding researches intended to enhance their own well-being. This would usually be done through Colonial Governments. Without doubt, one of the means of creating and maintaining an interest in research, and in due course of putting its findings into practice, will be to have work actually in progress in the territories concerned, and wherever possible to seek co-operation with interested local bodies. In this matter, the highly developed tradition of hospitability in Colonial life should do much to smooth the way.

The new Colonial research fellowships which are to be offered will almost certainly command wide attention and create stirrings in the minds of young men, who, after a longer or shorter spell of research at a university or kindred institution, may wish to adventure abroad. The aim is to create a cadre of men of science versed in Colonial problems. Many good results should follow the launching of this scheme; not least, the horizon of the scientific world will be enlarged by being familiarized with Colonial problems and the opportunities they afford for new lines of work. These fellowships will be "open to qualified scientists, whether in the natural or in the social sciences, to enable them to pursue research work in the Colonial Empire. The Fellowships will normally be for two years, and the Secretary of State hopes that Universities and other research institutes will be willing to grant applicants, if already members of their staffs, leave of absence for this period in order to enable them to take up the fellowships. Provision has been made for twenty-five such Fellowships within the next five years. It is recognized that war-time shortages of personnel will restrict the immediate applicability of the scheme; it is, however, being brought into force immediately, in case there are suitable candidates in any part of the Empire who are not at present required for urgent war-time work."

It may be said that the Research Committee takes a modest view of its activities. "The Committee are conscious that the list of specific researches approved since their Progress Report is short, and they would not wish it to be understood that they consider that the present rate of progress would be satisfactory in normal circumstances. But conditions are not normal, and, moreover, the Committee have been impressed by the fundamental importance, if a proper rate of progress is to be achieved when normal conditions return, of a sound basic organization. They have felt justified, therefore, in devoting the greater part of their attention to the problems of organization which have been described in this report."

The second document gives an idea of the many and varied schemes, including research, welfare and development, which have already been approved and are being financed (by free grants and loans) under the Colonial Development and Welfare Act (1940) up to March 31, 1944. Here the extent of support given to specific projects is set out. Food production, road-making, irrigation, agricultural development, water supplies, medical and health services, education, mosquito control, airfield construction, are only a sample of many items. Taken together, they afford a vivid impression of how vast and varied are the Colonial commitments of Britain and how much needs to be done, sometimes to make good overdue omissions, at other times to prepare for a brighter and better future. The battle with the tropics, which is unrelenting and has to be fought on many fronts, calls for all the weapons at our command. It is good to know that reinforcements are on the way.

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## EXPERIMENT AND THEORY IN PHYSICS

Experiment and Theory in Physics
By Prof. Max Born. Pp. iv+44. (Cambridge: At the University Press, 1943.) 2*s*. net.

THE question of the relation between theory and experiment in physics is one of perennial interest. It is, of course, only one aspect of the fundamental philosophical problem of the general relation of the rational to the empirical, and it is not too much to say that the peculiar character of progress in physics during the last generation has made it, for the time at any rate, the most important aspect of that problem. Certainly no one can contemplate the development during this century of both macroscopic and microscopic physics—relativity and quantum theory—without realizing that, whether or not his philosophical outlook has been modified thereby, its most appropriate expression must be very different from any which was possible previously.

We can no longer accept unquestioningly the naïve view that we are gradually learning the secrets of an objective world which exists in complete independence, undisturbed by our inspection and apprehension of it. We are bound to recognize that our activities, in theoretical physics at least, are not so much those of discoverers of unknown lands as those of creators of works of art. We do not look for the 'reality' behind experience, but seek to create a language in which the relations between our experiences can be most comprehensively and elegantly expressed. The statements of these relations are our 'Laws of Nature', and the question presents itself: Are these laws deducible only from experience itself, or are they *necessary* relations which could have been formulated, and recognized as relevant to experience, by a sufficiently powerful intelligence from pure reason alone, without reference to experience? The question, be it noted, implies the independence of reason and experience, for it contemplates the possibility that a being without experience might still reason effectively. We can evade any psychological objection that might be made to this assumption by supposing, if necessary, that our reasoner has had his reasoning faculties created or sharpened by experience which he has then completely forgotten. The question then remains: Could he formulate relations, to which any physical experience which he might afterwards acquire must conform, those relations being of the kind which we usually call laws of Nature and have in the past believed not to be derivable by reason alone?

The great majority of physicists, I believe, would answer this question in the negative, though they might be prepared to admit that the present formulation of physical laws owes more to reason and less to experience than we have been accustomed to assuming. Two outstanding thinkers, however—Sir Arthur Eddington and Prof. E. A. Milne—have independently given an affirmative answer. They do not necessarily deny the value of experience as a practical device for deriving the laws, or the possibility of factual details of experience which the laws cannot foretell; nor do they claim the perfection of intelligence needed for the rational deduction of the supposedly inevitable relations, though they do proceed some distance along the logical path and describe it quite differently. But they agree in asserting that the whole scheme of physical law, in an ultimately complete form, is attainable by reason alone, and so resurrect a type of philosophy which the scientifically minded since the time of Galileo and Newton have regarded as completely and irredeemably annihilated.

This phenomenon is justifiably regarded in many quarters with some apprehension, but even the darkest cloud has a silver lining, and when we read in Prof. Max Born's admirable little booklet that he has been induced to write it from his conviction that the ideas of Eddington and Milne are a considerable danger to the sound development of science, we are inclined to grant that the wayward astronomers might after all be forgiven, since their doctrines have produced so happy an issue. Prof. Born is in an almost unique position to write on this subject. Not only has he contributed some of the most vital ideas to modern physics, but also he has been in close touch with nearly, if not quite, all those others who have helped to create the atmosphere in which the philosophy of Eddington and Milne has been able to develop. He is thus both well aware of the measure in which the originators of the new ideas regard their work as dependent on experience, and particularly competent to form a trustworthy judgment on the general question. His conclusion is this: "I believe that there is no philosophical high-road in science, with epistemological signposts. No, we are in a jungle and find our way by trial and error, building our road *behind* us as we proceed. We do not *find* signposts at crossroads, but our own scouts *erect* them, to help the rest."

The course which Prof. Born follows is that of showing "the mutual relationship between theory and experiment in the actual historical development of science". After a brief introduction on the empirical character of geometry and astronomy and of the "experimental philosophy" of Galileo and Newton, he examines the more modern ideas which at first sight appear to have had an *a priori* origin. The various 'minimum' principles such as that of least action, Maxwell's electromagnetic theory, general relativity, matrix mechanics, wave mechanics, thermodynamical statistics, are discussed in turn, and the parts played in their development by theory and experiment are illustrated. Attention is then directed more specifically to the theories of Eddington and Milne, and the author arrives finally at the conclusion stated above. The writing is clear and vivid, and is interspersed with personal reminiscences and illuminating analogies.

To attempt a more detailed précis of this fascinating paper would be to weaken it; it should be read in its entirety. A more fitting commentary would be a brief discussion of a few of the points which its perusal suggests. Prof. Born hits the nail on the head when he says, on pp. 8–9, "The problem of physics is how the actual phenomena, as observed with the help of our sense organs aided by instruments, can be reduced to simple notions which are suited for precise measurement and used for the formulation of quantitative laws". If that is so, then it naturally follows that the production of equations out of our inner consciousness is something different from a solution of the problem of physics. Let Eddington and Milne give birth to their equations and, if they will, suggest a distinctive name for the activity in which they are engaged; nothing more need be said on the matter. Unfortunately, however, we tend unconsciously to forget this simple and accurate definition of physics, and fall back on the older, discredited assumption that there exist, independently of our experience or our reasoning, certain objective, self-sufficing things called 'Laws of Nature', and that experience and pure reason are alternative instruments by which, in physics, these laws of Nature may be apprehended. Even Prof. Born seems at times to lapse into this attitude, notably in the earlier portion of his essay. From that point of view we can argue until doomsday whether reason or experience is the better instrument, and no one will be a penny the better. If, instead, we simply use our reason to organize our experience into quantitative laws, all such argument is seen to be irrelevant, and we become physicists again.

A suggestive line of thought is opened up by the remark on p. 18 that "Heisenberg felt that quantities which had no direct relation to experiment ought to be eliminated". We must, of course, accept Prof. Born's statement about Heisenberg's feelings, for he and Heisenberg worked together on the problem referred to, but as a general rule the restriction to quantities *directly* related to experiment is surely too drastic. Probably the first consciously realized application of this principle, in modern physics at least, was that of Einstein to the question of motion through the ether. Here the earth had been assumed to have a definite, though unknown, velocity, and the value of Einstein's achievement lay in his recognition that because, by no experiment that could be devised, could this velocity be unambiguously determined, the existing scheme of physical concepts should be reformed so that this inaccessible quantity should no longer appear to have any significance. The justification for this reform, however, lay essentially in the fact that the earth's velocity could not be determined by *any* means. If it could have been found, by however tortuous a process, without introducing any contradiction into theoretical physics, the special theory of relativity would have fallen to the ground. No one would have been obstinate enough to ignore the value obtained because a series of metre rods had not been nailed to the ether along the earth's orbit and the hour angles of the mean sun observed when the earth coincided with its successive marks.

The only acceptable 'operational' principle in physics is that which demands that every concept used shall be related, in a strictly specifiable way, to possible measurements. Any narrower requirement than this leads to absurdity. Consider, for example, Avogadro's number. This is definitely related to experiment, for its value has been experimentally determined. The relation—to take one determination as an example—is that if one makes all the measurements involved in determining the temperature and density of a liquid and its vapour at an observed pressure, and the viscosity of the liquid, and combines the results in a particular way into a complicated expression, the value of this expression turns out to be a large number which is approximately the same for various gases. This we call 'Avogadro's number', and denote by the letter $N$. It is a perfectly legitimate concept because it is related to experiment through the measurements referred to. But now, when we introduce a particular hypothesis, namely, that a gas consists of a multitude of similar small moving particles called molecules, which are responsible, through the type of behaviour which we assign to them, for the pressure, temperature, etc., that we measure, we find that the pursuit of our ideas leads us to identify $N$ with the number of molecules in unit volume of a gas. The direct experimental determination of a number of molecules, however, consists of a process of counting them, and this is impossible. Hence, if we define $N$ as a certain power of the reciprocal of the kinematic viscosity per unit . . . per unit . . . etc., it is directly related to experiment; but if we define it as the number of molecules per unit volume of a gas under standard conditions, it is not. Heisenberg's feeling, then, should lead him only to substitute a cumbrous for a simple name, while leaving the practice and the mathematical structure of physics unchanged. It is difficult to regard such an achievement with admiration.

In considering the legitimacy or otherwise of a physical concept, we must, then, ignore all hypotheses or theories which give a picturable significance to the concept, and take into account only its relation to actual operations of measurement. The hypotheses may be, and in practice are, essential for making progress, but they have no bearing on the question whether the concept may be used in physics or not. For this reason I find it difficult to agree with Prof. Born's view that operational definition "comes to grief in quantum theory". It is true that in that theory symbols are used of which we have not been able to give picturable correlatives, though Prof. Born's own invaluable interpretation of one of them as representing a probability should remind us that this is not necessarily a permanent characteristic. But an operational definition is not identical with a picturable metaphor; it is simply an expression of

the relation of the mathematical symbol, in its mathematical context, to measurable quantities, and this is possible in quantum theory as in any other part of physics. The remoteness of the relation has nothing to do with the matter, and may in any case disappear overnight when someone thinks of a new analogy.

Milne's claim that his theory obeys the operational principle raises objections of somewhat different character. In so far as an operation can be described which, if carried out, would yield numbers for the symbols he employs, those symbols may be said to be operationally defined. The trouble is that, for practical reasons, we can get no further than a description of the operations; actually to perform them we should require infinite time, an infinite army of slaves or disciples whom we could transport where we wished, and apparatus of infinite delicacy, to say nothing of the absence of any unsuspected difficulties throughout the great distances and durations involved. This would be of little consequence if it prevented only the final verification of a theory made probable by other observations, but in Milne's theory it is the very first requirement. Until these impossible demands are satisfied, physics cannot begin. Any agreement with observation that the theory might claim must therefore be obtained by departing from the operational definitions. Many, like Prof. Born, will "not wish to discourage anybody who feels in himself the vocation to embark on so adventurous a journey", but they will themselves prefer to see what can be done with measurements that can not only be conceived but actually made.

Like others, Prof. Born has not succeeded in understanding the essential parts of Eddington's theory connecting the constants of quantum theory with those of cosmology. That is not to say that there is nothing of great value in the theory. His final comment is perhaps the wisest that has yet been made on this subject: "I am far from attacking Eddington's theories or from doubting his results. If they should turn out to be right I shall rejoice. But I shall not attribute this (possible) success to Eddington's philosophy, as a doctrine which could be followed by others, but to his personal genius and intuition." HERBERT DINGLE.

# POLLEN ANALYSIS

## An Introduction to Pollen Analysis

By Dr. G. Erdtman. (A New Series of Plant Science Books, Vol. 12.) Pp. xvi+240. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1943.) 5 dollars.

POLLEN analysis is the term applied to the quantitative analysis of material containing pollen, by microscopic recognition of the species and genera of plants from which the pollen came. The pollen membranes have qualities of shape, size, surface, and structure which permit these identifications, and their preservation is often excellent.

It was G. Erdtman, a Swede, who in the nineteen-twenties, by a series of papers written in English, introduced British and American scientific men to the principles and technique of pollen analysis, a new method of geological inquiry which had recently been developed in Scandinavia, particularly by the energy and insight of L. von Post. The succeeding years have seen a very great extension of the applications of pollen analysis. Not only has it been used in countries in all parts of the world to elucidate their forest history, and thence the drift of former climatic conditions, but also it has been shown to afford the means of solving an unexpectedly wide range of problems. Thus, by the analysis of ice in the various layers of the great alpine Aletsch glacier, Vareschi has been able to recognize the regular seasonal alternation of preserved pollen, and on this basis has made important deductions about the character of glacier structure and movement. In the Swiss Alps, in the eastern United States, and recently in South Wales, analyses of the pollen content of the air at different seasons have proved valuable in studies of hay-fever.

It has long been recognized that dating of prehistoric objects and structures found in lake- or bog-deposits is often possible by reference to the geochronological scale afforded by the regular drift of forest history. Similarly, the course of relative movement of land- and sea-level may be effectively dated, and eustatic effects distinguished from isostatic. More recently, it has become apparent that not only is the former distribution of natural plant communities reflected by pollen analyses, so that the conditions of salt-marsh, lake, fen, forest and bog may be accurately recognized in buried layers, but also, as Iverson has shown (see *Nature*, April 29, p. 511), the influence of prehistoric man in modifying natural communities may be detected, together with the origin of the new anthropogenous vegetation he has created.

Hitherto no text-book of pollen analysis has been available, and we warmly welcome, therefore, the appearance of the "Introduction to Pollen Analysis" by Dr. Erdtman. He has himself in the last twenty years contributed important results to the field of pollen analysis. He has developed a technique of preparation by chlorination and acid-hydrolysis which very greatly simplifies counting of grains in materials poor in pollen: he has sharpened the technique of critical recognition of species by their pollen morphology, and he has contributed much to the knowledge of long-distance flight of pollen. In this book these matters are given adequate treatment, together with such related topics as the analysis of pollen in honey as a basis for determination of the country and season of its origin, and the geological use of spore-counts in coal seams.

The greater part of the book is nevertheless devoted to description of the morphology of a wide selection of pollen grains and spores, and of these very numerous drawings are given—very usefully all upon the same scale. The types included are largely north-west European, but a sprinkling of North American and other species is also included. The atlas of twenty-eight plates thus provided is certain to be of the greatest value to all who study pollen analysis.

There is still much to be written of the results of application of pollen analysis to recent geology, and we may perhaps feel that this field has been a little neglected by Dr. Erdtman; but it has been his purpose to direct study to the widest scope possible, and in this he has certainly succeeded. Both he and *Chronica Botanica* are to be congratulated on the easy and natural English of the book: many others deserve credit for having enabled production of the book to be carried through during a world war, with the author still in Sweden and his publishers in the United States. H. GODWIN.

# THE RUGBY EXPERIMENT

## From Learning to Earning

Birth and Growth of a Young People's College. By P. I. Kitchen. Pp. 168. (London: Faber and Faber, Ltd., 1944.) 8s. 6d. net.

THE establishment in due course of young people's colleges having almost become the law of the land, this book could not have appeared at a more opportune moment. In a general way, the story it tells is well known. In a couple of years, the day continuation school clauses of the Act of 1918 became, at any rate in the sense in which their author meant them, a dead letter—except at Rugby. The story with its sequel is here set forth by Mr. Kitchen, who since 1919 has been principal of Rugby College of Technology and Arts, and organizer of further education at Rugby. He describes his book as a simple account of a small-scale experiment for assisting youth in its dangerous crossing over the no-man's land between school and work,' and he hopes its realism may prove a refreshing contrast to the chorus of reconstruction programmes now emanating from the idealists.

The Lewis Committee of 1917 reported the occupations of children of 14 plus as amounting to a small proportion of apprenticeships and a large proportion of blind-alley jobs and seasonal work—a fruitful source of juvenile delinquency. The Committee confidently recommended compulsory day continuation schools, and the recommendation was adopted by Mr. Fisher in the following year. (It may be observed that the dismal account given by Mr. Herbert Lewis's Committee in 1917 is just as true in 1944.) Appointed days were fixed in a few places, of which Rugby was one, for the operation of the clauses in the Act which made attendance at continuation schools compulsory. Rugby's appointed day was April 13, 1920, and Rugby proceeded with its preparations.

An enthusiastic staff resolved to give the go-by to the old order of marks, examinations, reports, competitions, rewards and punishments, and to create a new order in which control was to be self-control, and discipline a disreputable word. The guiding principle was free activity, and precious time was not to be wasted on vocational education. To cut a long story short, the scheme received an unexpected shock. It satisfied nobody. With employers murmuring, parents dissatisfied, public opinion uneasy, and young people themselves "overdosed with high lights, play and freedom", the programme of the compulsory day was replanned on the old lines, and freedom was reserved for voluntary evening work, where it thrived. A modern curriculum was eventually devised, of which the underlying principles will no doubt receive careful attention in many other places besides Rugby.

But Rugby's decision to stand alone as the pioneer compulsory day continuation school was likely to incur criticism and animosity, and a hard struggle ensued, especially after the promising London attempt and the Kent scheme both had to be abandoned. The school was, of course, an isolated institution, and was regarded by some as a mere curiosity, but by the more far-seeing as a possible "spring-board for a second forward movement, better timed and more carefully prepared, with a more successful issue". The author adds an account of the birth and growth of the technical and art school; and it is to be noted that the Rugby experiment is entirely favourable to the association of all forms of part-time schooling in one college building, with all types of pupils learning and growing together. "All gain much by the example of and contact with others, old or young, bright or dull, ambitious or indifferent, engineers or artists, conscripted or voluntary, scholarship or paying pupils."

The story of the Rugby experiment needed to be told, and it is most fortunate that the story has been told so worthily. The total impression left upon the attentive reader is quite clear, and there is not a dull sentence in the book. A good deal of it is a record of a real fight, a struggle for existence, in which the more enlightened employers and parents, and the practical support of the great school near by, helped to secure a victory.

T. RAYMONT.

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# EVOLUTION OF A LAND POLICY

## The Arkansas Plantation, 1920-1942

By Donald Crichton Alexander. (Patterson Prize Essays, Yale University, Vol. 2.) Pp. 118. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1943.) 6s. 6d. net.

THIS ably written essay deals with far wider issues than its title suggests. It reviews the disastrous condition into which American agriculture in general, and the cotton-growing industry in particular, fell between the two World Wars, and the gradual evolution of measures to remedy this. The United States had become a creditor nation, and she failed to realize that a policy of high industrial tariffs was limiting trade with her neighbours. The tariffs maintained industrial prosperity for a time but aggravated the agricultural depression. Huge stocks of cotton accumulated and growers went bankrupt.

An account is given of the dismal failure of the Harding, Coolidge and Hoover administrations to understand and deal with the problem. Under Roosevelt, effective action was taken and an Agricultural Adjustment Act was passed; but in 1936 the Supreme Court announced that it was unconstitutional. Soil conservation had been a secondary objective in this Act, but under a new Soil Conservation and Domestic Allotment Act passed in 1936 it took first place. According to Mr. Henry Wallace, the Act had five objectives: "Preservation of soil fertility, diminution of soil exploitation, promotion of the economic use of land, the protection of rivers and harbours against the results of soil erosion and the attainment of parity income for agriculture". This Act failed as a means of acreage control, and a second Agricultural Adjustment Act was passed in 1938 in which preservation of soil resources is still a basic objective. Another interesting point is that it contains provisions designed to gain a wider market for the farmer; these include the establishment of four regional laboratories for research and development of new uses for farm products, a scheme that might very profitably be studied in Britain.

The author's easy and lucid style makes the book a pleasure to read, and in view of the difficulties through which British agricultural industry has been passing it will be of interest to many who are concerned with farming.

It is to be hoped that in framing our own agricultural policy due consideration will be given to that most important factor, the maintenance of soil fertility, and that attention will be directed to research on improved and new uses for agricultural products.

W. G. OGG.

# LIGHTNING CALCULATIONS WITH LIGHT*

By Sir LAWRENCE BRAGG, O.B.E., F.R.S.

WHEN we attempt to infer the positions of the atoms in a crystalline structure from measurements of X-ray diffraction, all methods reduce in principle to a matter of 'trial and error'. The investigator tentatively places the atoms in certain positions, using judgment and past experience to set up an arrangement which does not conflict with interatomic distances and probable groupings. He then calculates how such an arrangement would diffract X-rays, and makes a comparison with what is observed. If there is no correspondence, he must try again. By eliminating possibilities and by adjustments of any structure which shows hopeful signs of checking with observations, he finally arrives (if successful) at an arrangement which he can regard as established. All this involves an immense amount of calculation. He may, for example, make measurements of a thousand diffracted beams. For each model, he must calculate the intensities of diffraction and compare it with what is observed. When the structure is complex, containing many atoms, there are so many possible permutations and combinations of the atomic positions that considerable courage and perseverance are necessary. A structure of a new type, such as a complex silicate or an organic molecule such as a sugar, has often meant one or two years of hard work and the accumulation of drawers full of calculations. The labour is well repaid, because so often a new structure casts quite a new light on an important chemical problem. Any method, however, of reducing the labours of calculation, and so saving the time of the expert, is of value.

I wish in this account to describe some methods of making light do our calculations for us. These methods are not so precise as those of computation, at any rate as yet. They are rough and ready, but quick, and I think they are promising and may be developed into a really useful tool. It is as if we were doing an approximate sum with a slide rule, to see whether the answer is about right, before turning to the logarithm tables for a more precise calculation. I have therefore called this discourse "Lightning Calculations with Light".

## The 'Fly's Eye'

Perhaps the most simple example with which to start is one which in point of fact has been one of the latest to be developed. I showed the first examples of it at a Royal Institution discourse in 1942. In X-ray analysis, it is usual to consider projections of the crystal pattern on certain planes for the sake of simplicity, so breaking down the diffraction problem into a two-dimensional one. It is familiar to workers in this field that the reflexions of X-rays by planes belonging to a zone (parallel to some crystallographic direction) simulate in their intensity the spectra which would be produced if light fell on a cross grating; the pattern of the cross grating is that of the crystal structure projected in a plane perpendicular to the zone axis. If therefore we can make a cross grating with a pattern like that of the crystal when viewed in a given direction, and use it to diffract monochromatic light, we should see a pattern of spectra which are bright or dim in accord-

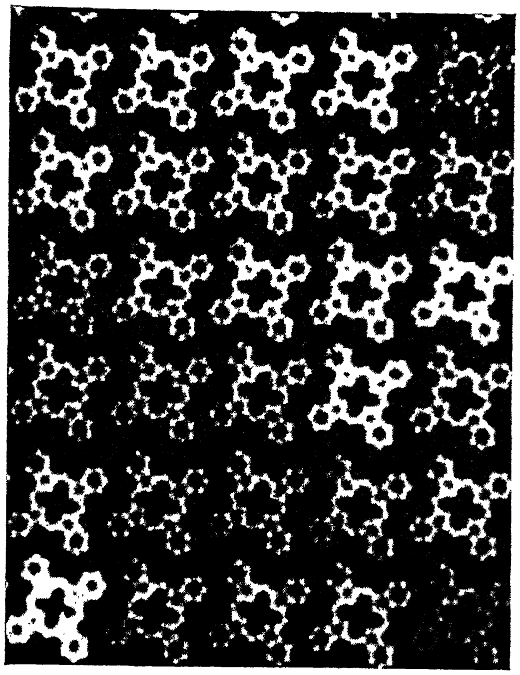


Fig. 1. Microphotograph of cross grating produced by the 'fly's eye'. (Bunn.)

ance with the corresponding X-ray spectra; for example, an array of spots corresponding to all the $hk0$ reflexions if the zone is the $c$ axis.

It would be possible to draw the crystal pattern on a large scale, and photograph it down so as to make a cross grating; but this would be tedious. The 'fly's eye' device makes the construction of the grating a simple matter. A master plate is prepared which consists of a pattern of minute transparent holes 0·04 mm. in diameter in an opaque background. The plate is the negative of a large-scale pattern of

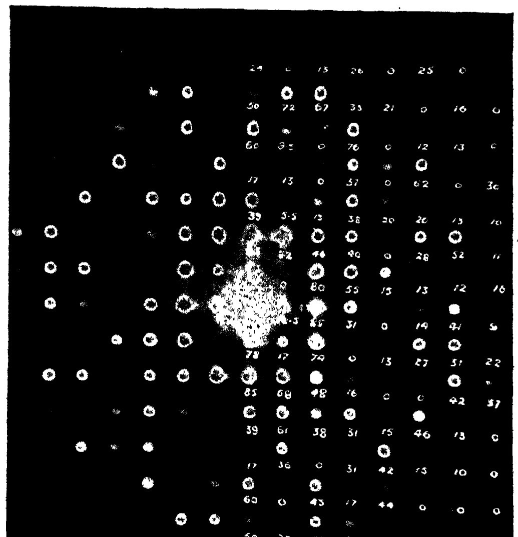


Fig. 2. Cross grating spectra given by the grating shown in Fig. 1. (Bunn.)

* Friday evening discourse at the Royal Institution on March 24.


Fig. 3.

black spots which is photographed down. The holes are spaced about 40 to the centimetre each way. The master plate is laid on a photographic plate with small distance pieces which keep the two surfaces 1 mm. apart. The plate is exposed to a single unit of the crystal pattern, represented by a cluster of lamps at a distance of about one metre; each hole in the master plate throws a pinhole image of the array on the photographic plate, so that the pattern is repeated for every hole. The plate is developed and used as a cross grating. A convenient method is to focus a telescope on a pinhole source of monochromatic light, and place the cross grating in front of the objective.

The method has been greatly improved by Bunn, working in the research laboratory of Imperial Chemical Industries, Ltd., at Northwich. Fig. 1 shows a microphotograph of a cross grating produced by the 'fly's eye'. The units represent the phthalocyanine molecule as determined by Robertson. Fig. 2 shows the cross grating spectra given by the grating, and the numbers represent the strength of the observed X-ray spectra. It will be seen that the correspondence is quite encouraging. The holes in the master plate were in this case at the corners of squares, whereas the unit cell of the crystal projection had no such simple symmetry. However, provided the atoms in the pattern unit have the right co-ordinates expressed as fractions of the cell edges, the interference pattern should check with the X-ray results. The grating in this case was made by moving a single lamp to successive positions of the carbon atoms in the structure unit, and taking an exposure for each position. Since the effective atoms are all carbon and nitrogen, they can be taken to be equal in scattering power. Some research will be necessary to reproduce a pattern of atoms of different kinds in a correct quantitative way, but trial and error will no doubt enable one to arrive at a set of empirical rules which lead to the right quantitative results.

The procedure for crystal analysis is thus as follows. Any proposed structure which is to be tested is drawn to scale, and a lamp placed at each atom in turn. If a number of variants are tried, a series of corresponding cross gratings can easily be photographed side by side on the same plate since each is less than 1 cm. square. By viewing a pinpoint light through them, one can see immediately if any one of them is near the truth.

## The Molecular Scattering Factor

The strength of each diffracted beam in a cross grating pattern is determined by the amount scattered by the unit of pattern in that particular direction. The amount scattered by a single unit is a continuous function of the direction of scattering. In the two-dimensional problem, this function, which is the molecular scattering factor, may be plotted by using contour lines to outline places where it is strong and where it is weak. When the unit is repeated regularly in space, diffracted beams only appear in certain directions (cross grating spectra). If therefore we superimpose on the graph representing the structure factor a grid such that its intersections represent the positions of the spectra, whenever a spectrum falls on a high contour it will be strong and when it falls on a low one it will be weak.

Fig. 3 shows the apparatus for calculating molecular structure factors by using light interference. A pinhole is placed at $F$, at the focus of the lens $A$. Light from a lamp $L$ passing through the pinhole is made parallel by $A$, and passes through a screen $G$ which has a pattern of holes representing the pattern of atoms in the structural unit. A second lens $B$ is identical with $A$, its focus being at $S$. The light waves from the holes in the screen $G$ interfere to build up at $S$ a pattern representing the molecular scattering factor, which can be viewed through the microscope $M$.

Instead, therefore, of building up a complete cross grating as in the 'fly's eye' method, we merely make up a single unit of pattern, representing the atoms by holes in the screen at $G$. A photograph is taken of

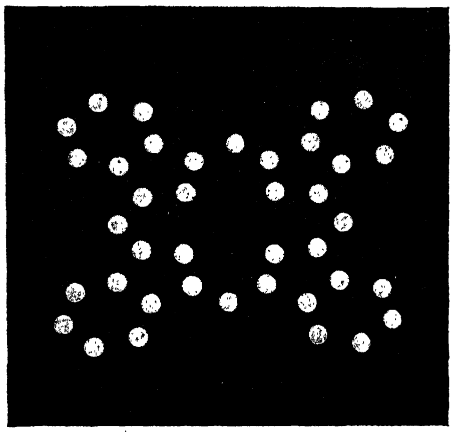


FIG. 4 (a).

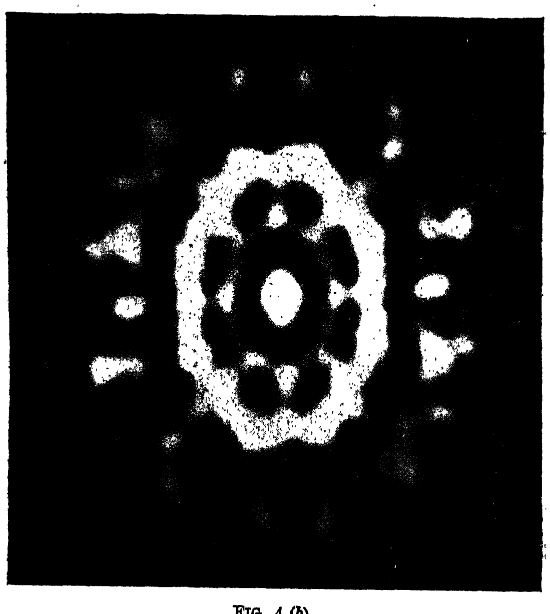


FIG. 4 (b).

Fig. 4. (a) PHTHALOCYANINE MOLECULE. (b) MOLECULAR SCATTERING FACTOR. (FOR COMPARISON WITH (a) REVERSE RIGHT TO LEFT.)

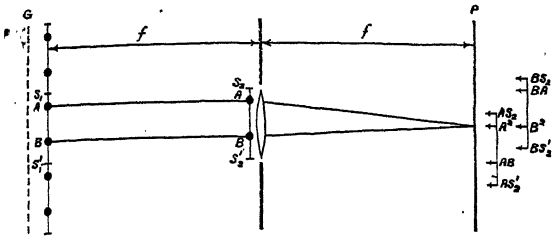


Fig. 5. THE CONSTRUCTION OF A PATTERSON DIAGRAM BY ROBERTSON'S METHOD.

the consequent diffraction pattern at $S$. This is enlarged, and covered by a grid to the right scale which defines the positions of the cross grating spectra. A comparison is now made with a diagram setting out the strength of the observed X-ray beams, plotted to the same scale. If strong and weak X-ray beams correspond to points on the grid where the diffraction pattern is strong and weak respectively, the right pattern unit has been found. Fig. 4*b* shows the molecular scattering factor of the phthalocyanine unit represented in Fig. 4*a*. The fringe pattern before enlargement is about 2 mm. in diameter.

## Patterson Synthesis

The 'Patterson' or 'Vector' diagram is much used in X-ray analysis. We may consider the projection of a crystal on a given plane for the sake of simplicity, though the principle is the same in three dimensions. The electric density of the unit of pattern, projected on a plane, can be represented by a set of contour lines like those on a map which give heights. Such diagrams will be familiar to anyone who has followed the later developments of X-ray analysis. They give the density $\rho(x,y)$ at any point $x,y$ in the unit cell. The Patterson diagram is more complex. It is a plot of a function $P(x_0,y_0)$ which at the point $x_0y_0$ has the value of the double integral taken over the unit cell.

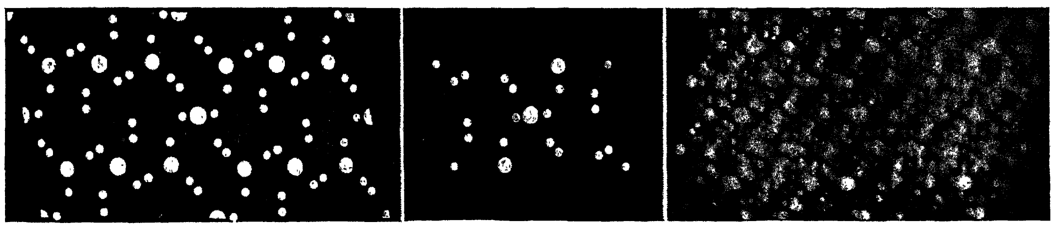
$$\iint \rho(x,y).\,\rho(x + x_0,\, y + y_0)dxdy.$$

It is called a vector diagram because its peaks represent vector relationships between the atoms in the pattern unit. If there is an atom at $x'y'$, and another at $x' + x_0$, $y' + y_0$, the densities will be large around both these points, and so the integral will have a large value around the point $x_0\,y_0$ in the Patterson. Every pair of atoms gives a peak. There is a large peak at the origin, since each atom multiplies itself, so to speak, at this point. The Patterson is complex, because if there are $n$ atoms in the unit cell there are $n^2$ superimposed Patterson peaks, of which $n$ are at the origin. The advantage of the Patterson is that it can be formed directly from the observed X-ray results, in a way indicated in the next paragraph. It often gives a clue to the positions of outstandingly heavy atoms in the structure, or to repeated vector relationships.

Robertson[1] has recently published an ingenious method of constructing the Patterson, given the crystal structure. A variant of his method referred to briefly at the end of his paper is illustrated in Fig. 5. Hägg[2] has suggested a similar method. To get the Patterson, we must (so to speak) multiply the crystal structure by itself.

The atoms in the unit of pattern $S_1S'_1$ are represented by holes in an opaque plate. These appear again at $S_2S'_2$, which is in contact with a long-focus lens. The distances $S_1S_2$, $S_2P$ are equal to the focal length. $S_1S'_1$ is backed with an illuminated sheet of ground glass $G$. The Patterson pattern appears on the screen $P$. The light coming through each hole such as $A$ multiplies the complete pattern at $S_2S'_2$ and throws it on the screen in such a way that $A^2$ appears at the focus $F$, the origin, while $AB$, $AC$, etc., appear in their proper vector relationship to the origin. Similarly, another atom $B$ produces $B^2$ at $F$, whereas $BA$, $BC$, etc., appear in their vector relationship. Fig. 6*a* and *b* show the two screens for the case of $CuSO_4.5H_2O$ projected on the *b* plane, and Fig. 6*c* the resulting Patterson. Alternatively, the lens can be dispensed with by making $S_2S'_2$ on half the scale of $S_1S'_1$.

If therefore the Patterson has been formed from the X-ray results, and we wish to check if a postulated crystal structure gives the same Patterson pattern, we need not calculate the latter. It is sufficient to reproduce the pattern at $S_1$ and $S_2$, and use the arrangement of Fig. 5.



(*a*) (*b*) (*c*)

Fig. 6. (*a*) FIRST SCREEN FOR PATTERSON CONSTRUCTION ($CuSO_4.5H_2O$, *b* PROJECTION). (*b*) SECOND SCREEN FOR PATTERSON CONSTRUCTION. (*c*) THE PATTERSON PATTERN. (FOR COMPARISON WITH (*a*) AND (*b*) REVERSE RIGHT TO LEFT.)

Certain precautions have to be taken. An atom in the pattern unit at $S_2$ which appears at a corner of the cell must be quarter strength, one on an edge half strength, and $S_2$ should be a single unit cell. $S_1$ can be a repeated pattern. In this way the final result at $S$ will have the correct overlapping of peaks of the right strength.

## Building up Fringes

For the sake of completeness reference may be made to the building up of a crystal image by superposition of fringes, though it will not be described here as it has been published elsewhere[3]. Referring to Fig. 3, if two small holes are made in the screen at $G$, a series of fringes will appear at $S$. The amplitude of the fringes is determined by the size of the holes, their orientation is at right angles to the line joining the holes, and their spacing is inversely proportional to the distance between the holes. We can therefore superimpose at $S$ any series of fringes by making the corresponding holes in $G$. The only

variable not conveniently at our command is their phase. Now the Patterson of a crystal can be built up by superimposing elements of a Fourier series, all of which are in phase at the origin or cell corners. The elements of the series are proportional to the measured X-ray intensities. If therefore holes are drilled in the screen $G$ to represent, as cross grating spectra, the intensities of the observed X-ray spectra, the result at $F$ is the Patterson diagram which light has calculated for us from the X-ray results. An example is given in the second article quoted above.

These methods of calculation are as yet in their initial stages, and much remains to be done to perfect them. The success already obtained, in particular with the 'fly's eye' method, is, however, quite promising and they may well prove to be a useful additional weapon in the X-ray analyst's armoury.

[1] Nature, 152, 411 (1943).
[2] Nature, 153, 81 (1944).
[3] Nature, 143, 678 (April 22, 1939); 149, 470 (April 25, 1942).

# WEST AFRICAN AGRICULTURE

By SIR GEOFFREY EVANS, C.I.E.
Royal Botanic Gardens, Kew

IN the spring of 1938 the Trustees of the Leverhulme Trust invited four members of Parliament to visit West Africa and report upon conditions in the West African Colonies generally. The terms of reference included a study of the standard of life of the native population, the production of food and other materials and in particular certain problems in respect of the development of agriculture, pastoral work and forestry. The investigations considered the problem of the improvement of farming methods and the introduction of new crops; the study of export crops, forestry and animal husbandry and the general problem of soil conditions, including erosion and improvement by better methods of cultivation. Lastly, the existing systems of land tenure were examined with the view of ascertaining whether modifications would be likely to be advantageous in the fullest development of the land. These objects were distinct from the more political aspects of the work of the Commission, and for the purpose of the inquiry certain technical experts were attached. The Technical Reports of the Commission have now been published; that on crop production and soil fertility is a valuable and informative document*. The Commissioners in their foreword to the Report lay down a principle—with which all who have acquaintance with these territories will agree—that any future economic development must be based on the fundamental importance of farming as the major interest of the African people. In view of this the Leverhulme Trust was fortunate in securing the services of such eminent men of science as Mr. H. C. Sampson, with his unrivalled knowledge of agricultural problems in India and East Africa; and Dr. E. M. Crowther, head of the Chemistry Department of Rothamsted, who is an acknowledged authority on tropical soil problems.

The outbreak of hostilities delayed the publication of this Report, and in the meantime the impact of war during the last five years has had the effect of changing conditions in West Africa as in other parts of the world. Nevertheless, the Report gives a faithful and very detailed account of agricultural conditions in the West African Colonies, and the facts related, together with the general conclusions reached, are as true to-day as they were before the War, for certain of the fundamental problems involved cannot be settled in a few years, but will only be resolved as the result of a well-planned and carefully thought out policy applied over a number of years.

The need for organizing research and survey on a much larger scale is stressed with the objective of working out an ecological interpretation of the country and its mode of life. That such surveys are needed is generally conceded, but progress in this direction has been hampered by lack of trained staff. The most striking piece of work hitherto has been achieved in the extreme north of the Northern Territories of the Gold Coast. Here a detailed ecological survey of the thickly populated strip of country comprising the granitic soils of the Dagombo peoples has been followed by the application of a definite system of improved agricultural methods. Elsewhere this principle has been adopted in a more piecemeal manner, but it may be said that in all cases where definite progress has been made, it has always followed the preliminary study of native methods of cultivation and has usually resulted in the grafting of the improved methods on to the native systems rather than the introduction of completely novel methods.

The section on geology and soils forms a valuable addition to our knowledge, and it is worth the study of all officers, administrative as well as agricultural, for the improvement, and, in the final instance, the saving of the soil, is the basis of all agricultural prosperity. The interesting suggestion is put forward that many of the traditional agricultural practices are to be explained in terms of the mineral nutrients necessary for plant life. Generally speaking, it may be said that West African soils are not particularly fertile, and indeed in large areas they are definitely poor. Organic matter decomposes much more rapidly in the tropics than it does in temperate climates, and many of the soils in the dry tropics are short of humus. Most of the surface soils in the wet zone are very deficient in bases and notably lime, phosphates, and potash; an exception being the rich volcanic country around the Cameroon Mountain.

The general shortage of lime is evident in many ways. Thus the native cattle and wild animals are smaller in the wet areas, where the lime and other minerals are readily leached out of the soil by the heavy rain, than in the dryer zones to the north. In the forest areas where cattle can with difficulty live owing to the attentions of the tsetse fly, the application of farmyard manure is not practicable, and experiments are now being conducted by the Agricultural Departments in Nigeria, in particular, to try to replenish the surface soils by means of the residues of certain deep-rooted shrubs which it is believed will draw these mineral nutrients from the subsoil. There are large areas in the country east of the Niger where the soil is so poor that it is impossible to establish a leguminous cover crop, and it is presumed that this is due to the lack of essential minerals. The present custom of cutting and burning the bush, growing a couple of crops and then allowing the land to recover by reverting to bush for a long series of

* The West Africa Commission, 1938–39. Technical Reports. 1. Crop Production and Soil Fertility. By H. C. Sampson and Dr. E. M. Crowther. (London: Leverhulme Trust.)

years, although destructive to timber supplies, was fairly effective so long as there was a sparse population. But in the Ibo country east of the Niger, the population is increasing rapidly and already in some districts it is 1,200 to the square mile. Here the resting period has perforce had to be reduced to two or even one year, so that this land has no time to recover and is rapidly deteriorating. There is no doubt that the evolution of a permanent system of husbandry in the wet forest area is one of the most pressing problems and also one of the most difficult to solve. It is a matter requiring careful and continuous investigation over a series of years. It is believed that these deep-rooted species, such as the rosaceous shrub *Acioa barteri*, bring up nutrients from the subsoil, but there seems to be no definite knowledge with regard to the extent to which this occurs, and detailed information would be advantageous. A central research station to deal with these problems of cultivation in the Forest Belt is badly needed, since a solution is probably the most urgent of all tropical agricultural problems at present.

In the drier parts of the country where it is possible to keep livestock, considerable progress has been made in establishing systems of mixed farming, whereby farmyard manure becomes available for the replenishment of the soil.

Somewhat remarkable results have been obtained by the application of dressings of one or two tons an acre. Such light applications would be considered homœopathic in Great Britain, and an interesting theory is put forward that the increase in yield may be due, in the main, to the minerals and not so much to the humic content of the manure. Further trials with mineral fertilizers are advocated. Phosphates in particular appear to be short, and it is pointed out that whereas rock phosphates may give good results in the acid soils of the Forest Belt, the more soluble fertilizers such as superphosphate may give better results in the neutral soils of the north. The argument that the peasant is so poor and so conservative that he will never readily take to artificial fertilizers is really unsound. In India the *ryot*, who was always considered one of the most conservative of beings, now uses large quantities, but he had to be converted to the value of the practice by prolonged and visual demonstrations. It must also be remembered that large numbers of African peasants have joined the Armed Forces during the last four years and have gained a measure of education and a widening of outlook which will undoubtedly have a big effect on village life when they return after demobilization. All these men will have travelled a good deal and will have learnt a lot from their contact with other peoples and other countries. Most of them have learnt to think for themselves, and will be quicker to take up any new method which promises to be advantageous.

As has already been mentioned, the African soils are deficient in certain important plant foods. The discovery of good deposits of agricultural lime or a reef of good phosphatic rock would be of untold benefit. There are phosphatic rocks in the Yoruba country, but there is no factory for making superphosphates. As it is at present, the country is losing most of its minerals through the export crops such as oil seeds and cacao. The north is also losing vast quantities in the shape of its cattle and animal products. If means could be found to slaughter the cattle in the north instead of sending them down to the coast on the hoof, the bones, horns and other residues could be retained and worked up into superphosphates, dried blood and other fertilizers, and the minerals would find their way back to the land where they came from. As it is at present, the drain from the land each year, in the shape of ground-nuts exported to the coast, is very considerable.

On the subject of erosion the authors very rightly stress the need for urgent action. Soil erosion is evident everywhere to a greater or less degree, and is particularly severe in the Protectorate of Sierra Leone, where the burning of steep slopes for the cultivation of hill rice is causing a rapid loss of soil and the impoverishment of whole areas. In the Ibo country of south-east Nigeria erosion in its most spectacular form is seen, particularly in the Awka division. Here the soils are a light sand, and enormous chasms several hundred feet deep and miles long have been formed. These are extending rapidly and encroaching on the agricultural land, which is already overburdened with a heavy population. Many of these areas are already gone beyond hope of reclaiming, and the best that can be done is to proclaim them forest reserves and get them covered with some sort of tree growth as quickly as possible. The real problem is to prevent further erosion by tackling incipient gulleying at the source and preventing sheet erosion by contouring, strip cultivation and bunding in the fields that are in cultivation. The problem is an administrative one and needs a united drive on the part of the political officers and the local authorities with the technical advice of agricultural and forestry officers. The whole problem involves careful planning, and decisions have to be made with regard to the allocation of certain areas as forest reserves in order to protect the water sheds and to afford shelter belts. The latter are particularly important as a protection against wind erosion in the dryer areas of the north where top soil may be lost by 'blowing', but it is also important in the regions nearer the coast because indiscriminate felling of the forests allows the 'harmattan'—that intensely dry north wind from the Sahara—access to the cacao plantations which require a humid atmosphere for their proper development. Incidentally the belief, current in many quarters, that the fine sand blown by the harmattan is altogether deleterious is not quite correct. It is pointed out that it is not a sand, but is composed of alkaline clay far richer in plant foods than the soils on which it falls, and although only small amounts are deposited each year they are likely to do more good than harm.

It is impossible to refer in detail to the section on crop plants, which are described in some detail, but some reference must be made to cotton and cacao. The former crop is chiefly grown in the Zaria province in Northern Nigeria, and complaints have been made from time to time that the type of American Upland cotton now grown is weak in staple. It is suggested that other species of cotton such as *G. punctatum* or some of the old native cottons might be developed. Shortage of staff and war conditions have prevented action being taken on these lines. Meanwhile, it is worth noting that the Upland cotton, which is an annual crop, seems to produce good strong cotton up to the advent of the harmattan winds in January. When these winds set in the cotton plants suddenly dry up and wilt, and any cotton picked afterwards tends to ripen prematurely and to be very weak in staple. It would seem desirable, therefore, to gin and bale this later picking separately from the main crop, which is picked before the coming of the harmattan.

With regard to cacao, much has happened since this Report was written. It is a remarkable fact that cacao plantations all over the world are now suffering much damage from diseases and pests. The effect seems to become cumulative as the crop reaches about thirty years. During the last five years officers working in the Research Station at Tafo, which was opened in 1937, have discovered that much of the damage that was formerly ascribed to die-back or physiological trouble is in reality caused by a virus or a virus complex, one symptom of which is the 'swollen shoot'. These viruses, together with the attack of capsid bugs, is menacing the whole future of the cacao crop, which is the prop and stay of the Gold Coast. The cacao has shown signs of trouble for years past; but it is only as recently as 1937 that research was contemplated. Now that the danger is apparent, the step recently taken to convert the Tafo Station into a Central Cacao Research Station to serve the whole of West Africa is a great step forward. The Station can now hope to be adequately staffed and equipped, and continuity in the research work will be assured, which was not always the case under the former conditions.

The sections dealing with the types of West African agriculture give a most interesting and accurate account of the methods and will repay careful study.

As regards plantation agriculture, it is pointed out that the present systems of land tenure and Government policy tend to hinder European plantations in our West African Colonies, though this is not the case in adjoining French territories or in the Belgian Congo. So far as the production of crops for export is concerned the plantation system has undoubtedly many advantages over production by large numbers of small individual farmers. It must be remembered that most of these tropical export crops have to be processed in some form or another before they can be marketed. The plantation with its central factory and assured supply of raw material can do this more efficiently and turn out a better product than the small individual. Arrangements can also be made to plant only the best varieties and to effect improvements in planting methods. It is also in a better position to meet the demands of the markets as regards quality, grade and so on, and has a big advantage in the arrangements concerning transport and sale. It was for these reasons that the plantation products of the Far East were rapidly ousting similar products from the West Coast in the period before the War. It would seem necessary to realize that some sort of central organization will be essential in the future and methods need to be worked out whereby the plantations can be organized on a co-operative or collective basis. By this means crops would be raised by individuals retaining many of their old rights and growing their own food crops, but collected round a central factory which would do the processing and arrange for the marketing and transport. A suitable site for such an experiment would be in the British Cameroons. Here agriculture is already based on the plantation system and these plantations, which were formerly enemy property, are being managed temporarily by Government. The soils are extremely fertile and other conditions favourable, and the experiment would be well worth making.

The Report is in every way an informative one and is illustrated by a series of excellent photographs which give a good idea of the lives and occupations of the various races that live in the British West African Colonies.

# EDUCATION IN PREVENTIVE MEDICINE

By SIR ARTHUR MACNALTY, K.C.B.

IN exploring a fresh field of knowledge in any subject, the pioneers have all the fun of the game. They devise their own methods and rules for investigation and try them out experimentally. It is necessary at length, when results have been achieved, to hand on the torch to others, and eventually an educational system, with professorial chairs, lecturers, text-books, demonstrations and the whole gamut of didactic instruction makes its appearance.

The preventability of disease had its ordered beginnings in the eighteenth and early part of the nineteenth centuries, and British practitioners of medicine took the lead of the world in this study. Richard Mead, in 1720, published his "Short Discourse concerning Pestilential Contagion and the Methods to be Used to Prevent it". John Pringle began hygienic reform for the British Army, and Dr. James Lind prevented scurvy and typhus. Other pioneers in preventive medicine were George Baker, Gilbert Blane, Edward Jenner and Turner Thackrah.

These men were all clinicians; they saw the consequences of disease, were not content with alleviating or curing maladies, but sought out their causes. In many cases they discovered that their patients' ill-health was due to bad environmental conditions—poverty, overcrowded dwellings, lack of fresh air and ventilation, filth, dirt and defective sanitation. Clinical medicine produced preventive medicine and constitutes its backbone. By a natural process of events, this new knowledge led to sanitary legislation, to a public health service and to systematic education in preventive medicine.

In an interesting inaugural lecture at the London School of Hygiene and Tropical Medicine, Prof. J. M. Mackintosh has traced the history of this education and foreshadowed its future trends.

It began in the year 1786 with Johann Peter Frank, who held the chair of clinical medicine in the University of Pavia and was appointed director of public health of Austrian Lombardy. In 1789 Andrew Duncan became professor of the Institutes of Medicine in Edinburgh and from 1795 gave weekly lectures on medical jurisprudence, devoting part of the course to the subject of "Medical Police", in which he dealt with both personal and environmental health, including hospitals and contagious diseases. In 1807 a university chair was created in these subjects with the stipend of £100 a year. At this time a number of British teachers were lecturing privately on hygiene, and books were written on the subject. John Roberton's treatise on "Medical Police" appeared in 1809, and in 1824 Gordon Smith defined the subject as "the application of medical knowledge to man in his social state"—no bad definition of social medicine. It was not until the year 1898 that the University of Edinburgh again had the distinction of instituting the first whole-time chair of public health.

The brilliant work of Sir John Simon and his colleagues at the Central Health Authority, and the appreciation of the work of those medical officers of health appointed by Liverpool, London and other progressive authorities, led to the obligatory general appointments of such officers by each local authority in 1872. By the Medical Act of 1886 (Section 21)

degrees and diplomas in public health were instituted. This opened the way for post-graduate teaching in public health to registered medical practitioners, and imposed on the General Medical Council the duty of controlling these qualifications and ensuring a proper standard of instruction. The first diploma was instituted by the University of Dublin in 1871, followed by Cambridge in 1875. Other universities and licensing bodies followed, and the Local Government Act of 1888 laid down that a registered degree or diploma in public health, sanitary science or State medicine was an essential qualification for a medical officer of health to a county or district of more than fifty thousand inhabitants. Regulations of the Ministry of Health now extend this requirement to all sanitary districts.

In the development of post-graduate study in public health, Prof. Mackintosh pays merited tributes to Sir Henry Acland, regius professor of medicine at Oxford from 1858 until 1894, Dr. William Stokes and Dr. Edmund Parkes.

H. W. Rumsey's essays on State medicine contributed much to education and practice. It is of interest to note that so early as 1856 he pointed out that the training and preparation of students for medical and sanitary employment was elsewhere acknowledged to be one of the most serious responsibilities of Government. He added: "It is one which no nation has ever neglected without loss to the State and injury to the people".

The seed thus sown has been long in fructifying, but we see some of its results in the University Grants Committee with its subsidies to medical schools, the foundation of schools with Government approbation and assistance, such as the London School of Hygiene and Tropical Medicine and the British Post-Graduate Medical School; and the recent report of the Royal College of Physicians with its suggestion that the cost of all medical education shall be defrayed by the State. Public opinion in Britain moves slowly. It is some ninety years since Rumsey wrote, and the nation is only beginning to realize its full responsibilities for the training and education of medical practitioners and post-graduates in its own vital interests.

The earliest examples of schools of preventive medicine in its broad and modern sense are the School of Hygiene and Public Health at Johns Hopkins University, the University of Toronto School of Hygiene and the London School of Hygiene and Tropical Medicine. All three schools drew much of their inspiration from a report prepared in 1915 by Dr. W. H. Welch and Mr. Wickliffe Rose and presented to the General Education Board of the Rockefeller Foundation. That Foundation in its wide generosity has promoted education in preventive medicine throughout the world and has made these three schools possible and successful. The first of them at Johns Hopkins University has admirably provided for research, intensive study and general instruction, and by its example has promoted the education and interest in preventive and social medicine throughout the United States. Gratitude is due in this respect to the labours of the late Dr. Welch, whose energy and enthusiasm was undiminished by the passage of years. In his planning of the School and its aims he had the advantage of the late Sir Arthur Newsholme's advice, and the latter's acceptance of the first lectureship in 1919 launched the new school under the best possible auspices. Equally the London School was fortunate in having at its helm such experts in preventive medicine as the late Sir Andrew Balfour and his successor, Sir Wilson Jameson.

In the beginning, organized preventive medicine concerned itself principally with environmental hygiene. The medical officer of health was regarded as a sanitary official chiefly occupied with administration and as having little concern with clinical medicine and the problems of disease, except in connexion with infectious fevers. Of late, preventive medicine has enlarged its activities by taking the individual in hand, by promoting facilities and education for keeping him healthy, and by preventing and treating disease in the individual in order to safeguard the community.

There was first the school medical service; then came the new health services for maternity and child welfare, tuberculosis and venereal diseases. The Local Government Act of 1929 placed many hospitals and other institutions under the control of the major health authorities, and the inter-war Housing Acts further increased the medical officer of health's responsibilities.

Prof. Mackintosh evidently realizes that there is much dead wood in public health education which might with advantage be cut away. This criticism applies both to undergraduate and postgraduate teaching. Too much detailed instruction is still given on sewage and refuse disposal and other problems of environmental hygiene concerning which the future medical officer of health only requires a general acquaintance, and the future general practitioner of medicine needs still less knowledge. The old syllabuses must be taken in hand and revised in the light of Prof. Mackintosh's counsel. Neither does it seem necessary for the public health student to spend so much time in the study of elaborate bacteriological technique and chemical methods of analysis.

Preventive medicine is not only changing but also advancing, and education in the subject must be adapted to the new discoveries and march of events. We see appreciation of the need for research and investigation in the recent founding of chairs of social medicine at Oxford and Birmingham. "In my view the primary aim of a School or University Department of Hygiene is to make good general practitioners in health, to send forth keen, competent men and women, with a high sense of their calling and a scientific outlook." Thus Prof. Mackintosh; and he goes on to emphasize the need in such a school for research in the basic sciences, the application of scientific work to the problems of public health, for example, through surveys, routine laboratory investigations, statistical and epidemiological studies and field experiment, the direct association with current health administration and direct teaching of the principles of preventive medicine. Furthermore, a school of preventive medicine must cater not only for the research student but also for the post-graduate student who desires to pursue intensive study in some special subject, such as statistics or biochemistry. If his bent is towards clinical subjects, for example, tuberculosis or pædiatrics, these are best studied elsewhere under a practising physician.

A course of preventive medicine must be largely academic and must be supplemented afterwards by the holding of clinical appointments to enable the intending medical officer of health to acquire the requisite experience for administrative posts, and to be in a position to appreciate and advise upon the

medical problems which will come before him. Let him beware of sticking too closely to his desk. He must visit clinics and hospitals to refresh his knowledge, be in sympathetic and friendly touch with his medical colleagues, play the man and not the bureaucrat.

These are revolutionary and epoch-making times. Great discoveries are being made in laboratories and hospitals which call for practical application in the prevention of human and social ills. It says much for the promise of the future that, in the midst of a world war, men of vision are able to find time to reflect, as Prof. Mackintosh has done, on the high ideals and humanitarian aims of teaching and practice in preventive medicine, and to plan for the years to come.

# OBITUARIES

## Sir Prafulla Chandra Rây, C.I.E.

BY the death on June 16 of Sir Prafulla Chandra Rây at the ripe age of eighty-three, Indian chemistry has suffered a severe loss. By his own contributions to science, but especially by his personal influence, Sir Prafulla was, more than anyone else, responsible for the great development of scientific research in India during the past fifty years.

P. C. Rây, the son of a small land proprietor, was born on April 20, 1861, and after receiving his early education in a village school he entered the Presidency College, Calcutta, where, although an arts student, he came under the influence of Sir Alexander Pedler, then professor of chemistry in the College, and he thus acquired an interest in chemistry. After graduation he gained a Gilchrist scholarship and in 1882 he proceeded to Edinburgh, where he studied chemistry, physics, botany and zoology. Here, after taking his B.Sc. degree, he worked in Crum Brown's laboratory, for whom he expressed his great admiration and affection. Remaining in Edinburgh for six years, he obtained the degree of D.Sc.; and, on his return to Calcutta in 1888, he was appointed an assistant in the Department of Chemistry at the Presidency College, later succeeding Sir Alexander Pedler in the chair. This appointment he held with great distinction until 1916, when he retired at the age limit and was appointed the first Palit professor of chemistry in the University College of Science. Here he continued to work until 1937, when increasing age and a partial failure of his eyesight compelled him to retire.

Both at the Presidency College and at the University College of Science, Rây built up outstanding schools of research, and nearly all the present professors of chemistry in the Indian universities have worked in his laboratory. Sir Prafulla's great activity over so long a period is all the more remarkable since his health was always poor. He was unmarried and led a very simple life, at one time living in a small room adjacent to the laboratory at the University College of Science. He devoted most of his income to providing stipends for his research students.

Rây's own researches were concerned mainly with the chemistry of the nitrites, and his first notable contribution was his discovery in 1896 of mercurous nitrite. Contrary to the view held previously, he showed that the nitrites are not unstable substances, and in a long series of papers published mainly in the *Journal of the Chemical Society*, he recorded the preparation of ammonium nitrite, the alkylammonium nitrites and various other members of the series. Important as were these investigations, it was by the enthusiasm for research with which he inspired his students that he will best be remembered. He found a further outlet for his energies by founding the Bengal Chemical and Pharmaceutical Works, now one of the leading firms in the Indian chemical industry.

Rây was profoundly interested also in the history of chemistry, and his "History of Hindu Chemistry" will always be regarded as a classical contribution to this field of study. In his later years he devoted much attention to the social and economic problems of India, and in his book "The Life and Experiences of a Bengali Chemist", published in 1933, he gave some account of this side of his activities. Although at times a severe critic of British policy he had a great affection for Great Britain, which he frequently visited. His knowledge of English literature was remarkable, and his tastes catholic, ranging from Shakespeare and Milton to "Tom Jones". He served as a member of a number of Government committees, and his intimate knowledge of India proved of great value in the deliberations of the Indian Chemical Services Committee, of which the late Sir Jocelyn Thorpe was chairman.

Sir Prafulla's services to science did not pass unrecognized; he was made a C.I.E. in 1912 and knighted in 1929. He was a fellow of the Royal Asiatic Society of Bengal and of the National Institute of Sciences, the first president (1924–26) of the Indian Chemical Society and a past president of the Indian Science Congress. His passing will be deeply regretted, not only by his Indian students to whom he was a true *guru*, but also by his many friends in Great Britain.

J. L. SIMONSEN.

## Prof. W. Biltz

ACCORDING to an announcement in the *Chemiker Zeitung* of January 12, Dr. Wilhelm Biltz, professor of inorganic chemistry and director of the Laboratories at the Technical High School, Hanover, died on November 13, 1943. Born at Berlin in 1877, Biltz had a long and successful career as a research chemist and became one of Germany's leading authorities on inorganic chemistry. His work covered a very wide field, for with a succession of collaborators he carried out investigations upon most of the chemical elements, in the course of which he prepared hundreds of new compounds, especially double halides and other double salts, and his work has helped to clarify knowledge of the chemistry of uranium, tungsten, molybdenum and, more recently, rhenium. In his earlier work he gave much attention to density and conductivity determinations of solutions, while later work led him into studies of affinity. This involved heating mixtures of an element and sulphur (or phosphorus, etc.) in varying proportions and submitting the products to X-ray and other methods of analysis (for example, tensimetric) to determine the formulæ of the sulphides, phosphides, etc.

In 1909 Biltz wrote "Laboratory Methods in Inorganic Chemistry", and was for many years joint editor of the *Zeitschrift für anorganische Chemie*, in which many of his papers appeared.

# NEWS and VIEWS

## British Electrical and Allied Industries Research Association

### Retirement of Mr. E. B. Wedmore, C.B.E.

WIDESPREAD regret will be felt throughout the electrical industry that, on account of ill-health, Mr. E. B. Wedmore will be relinquishing the directorship of the British Electrical and Allied Industries Research Association at the end of this year. Mr. Wedmore has been the guiding hand of the Association since its incorporation in 1921 from the Electrical Research Committee of 1918. The success the Association has met with has been due, in no small measure, to his personal efforts, which have always been typified by high administrative ability combined with a wide and thorough knowledge of scientific and practical engineering affairs. The work which has been done by the Association, under Mr. Wedmore's ægis, has embraced a particularly broad field, and in many of the most important branches he has himself been actively concerned. Prior to his association with the E.R.A., Mr. Wedmore's experience included the educational field and the electricity supply industry, and he was prominent as a switchgear designer in the manufacturing industry, being interested very largely in automatic protective systems. His book "Switchgear for Electric Power Control" was published in 1924. He is a member of Council of the Institution of Electrical Engineers, a fellow of the Institute of Physics and has been a notable participant in many national and international conferences and technical assemblies. He was awarded the C.B.E. in 1938.

Mr. Wedmore's non-professional activities reflect the breadth of his interests. He is very well known in bee-keeping circles, and his book, "A Manual of Beekeeping for the English-speaking People", first published in 1932, is regarded as a standard work; bee-keepers throughout the country have long been indebted to him for the great interest he has taken in both the practical and the theoretical sides of their craft. In his own quiet way Mr. Wedmore has done a considerable amount of research work on honey bees and has spent a large part of his spare time lecturing to bee-keepers' associations and doing similar work. He is a member of the Apis Club, and of the Back to the Land Club. For many years Mr. Wedmore has been interested in craniology as applied to character study and in practical aspects of the work of the probation courts. He has also been active in the development of the theory of colour and in the geometry of four dimensions. Mr. Wedmore will take with him the very sincere wishes for a speedy restoration to good health, and a happy retirement, of a large circle of friends in the electrical and associated industries, which include the staff of the Association and the members of the large number of committees through which the Association functions. From January 1 next, Dr. S. Whitehead will take up the duties of acting director of the Association, and from July 1 Mr. R. A. McMahon will become secretary of the Association.

## Astronomy: the Distaff Side

ROBERT S. RICHARDSON has an article with the above title in Leaflet 181 of the Astronomical Society of the Pacific, which shows the important part played by women in the advancement of science. Madame Curie is cited first of all, but most of the examples are taken from astronomy. The writer recalls with amusement the bewildered expression of visitors to the Lick Observatory on some public nights, when, instead of being greeted by an elderly professor, as they expected, they were given a lecture by a young woman. Several examples of the valuable contributions of women to the advancement of astronomy are cited. Madame Jean André Lepaute assisted Clairaut and Lalande in the computations of the perturbations of Halley's Comet by Jupiter and Saturn, and as a result of the work Clairaut was able to announce that the comet would pass perihelion on April 13, 1759. It actually passed perihelion 32 days before the time set by Clairaut; but as Uranus and Neptune were unknown at the time no account was taken of perturbations by these planets. Among other women of distinction reference is made to Caroline Herschel, Lady Huggins and Maria Mitchell, who assisted her father until she was forty-seven with routine computations in connexion with Government surveys for latitude and longitude. She was then appointed professor of astronomy and director of the Observatory at Vassar College, a position which she held until her death. In more recent times we have Miss Annie J. Cannon, Miss Antonia C. Maury and Miss Henrietta S. Leavitt. Not only have women made astronomy their career; they have also acted as patronesses, and notable among these are Mrs. Henry Draper, Miss Helen Snow, Miss Catherine Wolfe Bruce, Mrs. Alexander F. Morrison. Although nearly as many women as men do postgraduate work in astronomy with quite as much success, yet the total number of women engaged in astronomical research is small, because most of them become astronomers' wives instead of astronomers.

## U.S. Committee for Post-War Research for Army and Navy

A COMMITTEE on Post-War Research for the Armed Forces of the United States has been appointed. At the first meeting there were present Charles E. Wilson (*chairman*), vice-chairman of the U.S. War Production Board; Dr. F. B. Jewett, president of the National Academy of Sciences; Dr. J. C. Hunsaker, chairman of the National Advisory Committee for Aeronautics; Dr. K. T. Compton, president of the Massachusetts Institute of Technology; Dr. M. A. Tuve, Carnegie Institute of Technology; Major-General O. P. Echols, assistant chief of Air Staff; Major-General A. W. Waldron, General Staff Corps, chief of Requirements Section, Army Ground Forces; Brig.-General W. F. Tompkins, director of Special Planning Division, War Department General Staff; Colonel R. M. Osborne, Army Services Forces; Admiral E. L. Cochrane, chief of the Bureau of Aeronautics. Other members of the Committee are Brig.-General T. D. Weaver, director of Industrial Demobilisation of the Army Service Forces; Rear Admiral G. F. Hussey, jun., chief of the Bureau of Ordnance, and Rear Admiral D. O. Ramsey, chief of the Bureau of Aeronautics. The purpose of the Committee is to prepare a plan and organizational procedure which will ensure the continued interest of civilian scientific workers after the War, in scientific research for the U.S. Army and Navy.

## Mosquitoes in Britain

THE British Mosquito Control Institute at Hayling Island, Hants, has recently issued at the price of 1*s*. a useful pamphlet entitled "The Morphology and Biology of *Culex molestus*: Observational Notes for Investigators". The object of this publication is to facilitate the investigation of cases in which mosquitoes are causing (or periodically cause) annoyance in dwelling-houses or other buildings, especially those in 'built-up' areas. From among thirty species of mosquito known in Britain, *Culex molestus* closely resembles our commonest mosquito, namely, *C. pipiens*, in many ways. It is, however, a fierce and persistent blood-sucker of man, whereas *Culex pipiens* rarely (if ever) bites human beings. The species *molestus* can lay eggs without having had a blood-meal, although the number of eggs laid is much reduced. It breeds at all times of the year, and mating, unlike that of almost all other mosquitoes, can occur in a very confined space. So far as is known it breeds chiefly in accumulations of water in dark or semi-dark warm situations, but a good deal more needs to be found out on this subject and many other features regarding its habits. So far, *Culex molestus* has only been recognized in London, Harwich and Hull, but it needs to be known whether it has a wider distribution in the country. Anyone willing to help in this investigation can receive a free copy of the pamphlet mentioned on application to the Director of the Institute, Mr. J. F. Marshall, whose temporary address is "Wayside", 47 London Road, Cheltenham.

## Diets for Patients with Ulcers of the Stomach and Duodenum

THE Ministry of Food, in collaboration with the Ministry of Health, has prepared a twelve-page pamphlet of diets for patients with ulcers of the stomach and duodenum. This pamphlet, which is not intended for the general public, since the dieting of cases of the above type is a matter for expert supervision, is approved by the Food Rationing (Special Diets) Advisory Committee of the Medical Research Council and will, it is hoped, help general practitioners, and others professionally concerned with the feeding of such patients, to cope with difficulties of war-time food supplies. The pamphlet contains rules for feeding and planning diets, weekly menus and recipes for patients who have either recovered from the acute stage of peptic ulcer or from whom symptoms due to the ulcer have almost disappeared. In planning the menus, the aim has been to provide a reasonably varied diet based on the foods available under present conditions to these patients. Copies of the pamphlet may be obtained by those professionally concerned with the problem, on application to the Secretary (Public Relations Division), Ministry of Health, Whitehall, S.W.1.

## Incidence of Scarlet Fever

ACCORDING to the *Weekly Epidemiological Record* of March 2, in recent years scarlet fever has ceased to be a disease of any great clinical importance, but its geographical distribution is extraordinary as it is very frequent in northern latitudes and practically unknown in the torrid zone. In the seventies of the nineteenth century, its fatality in northern Europe was more than 10 per cent, and in mortality it exceeded any other acute infection. Between 1875 and 1885 the mortality was halved; it was halved again between 1885 and 1900, and in the present century it has fallen below 1 per cent. Scarlet fever is endemic in all parts of the world in which it occurs, but shows wide variation in incidence from year to year. During the present War, the incidence of this disease has shown no relationship to the public nutrition or the state of military activity, as is shown by the fact that in Germany, which is the best nourished country on the Continent and presents the greatest military activity, the incidence of scarlet fever is excessively high, as it is also in Norway, Holland and Greece, where the nutrition is low. In England and Wales, where the nutrition is good, incidence of the disease fell below normal until 1941, since when it has shown a slight increase. In the United States the numbers are still falling. It is noteworthy that in no country where returns are available has there been any reported increase of severity.

## Substitutes for Structural Material in South Africa

MR. N. Stutterheim and Mr. J. Shaw, of the Investigation Section of the Building Control, South Africa, described some work carried out by the Section during the ten months of its existence at a meeting of the South African Society of Civil Engineers on March 15. They discussed particularly the investigation of substitutes for steel and timber for building purposes. The work is being carried out in the Civil Engineering Department, University of the Witwatersrand, under Prof. Bernard H. Knight, acting head of the Department. The most promising material examined, taking South African conditions of service and also the question of supplies into consideration, appears to be 'Sorel' cement with sawdust filler, reinforced with wood lathes. It can be sawn, nailed and screwed, and tends to expand and contract with varying moisture conditions much as timber does. Its chief economic recommendation is that it can be cast to any size or shape without the use of high temperature, high pressure or skilled labour. Some houses have been built in Johannesburg in which all timber has been replaced with 'Sorel' cement composition. A sawdust cement composition has also been developed by certain South African firms. Other research work carried out by the Investigation Section has been the testing of tiles and flooring materials; for testing the latter, a machine has been devised in the University of the Witwatersrand consisting of leather pads fed with crusher dust to simulate the abrasive effect of leather soles and dust.

## Properties of Paracon

ACCORDING to an article by B. S. Biggs (*Bell Lab. Rec.*, 22, No. 7; March 1944), when the development of 'Paracon', a new synthetic rubber, was announced by the Bell Laboratories, its resistance to oil and heat and its low brittle point, lack of odour and fast curing cycle were emphasized. Not all these characteristics can be held at maximum values in every composition, but various combinations of them can be obtained by selecting the intermediate compounds used in manufacture. This follows because the 'Paracons', in contrast with most elastic compounds, comprise a group of compounds rather than a single one. Chemically, the 'Paracons' are chain esters of high molecular weight. Among the substances that may be used are sebacic and succinic acids and ethylene and propylene glycols. These chemicals are obtainable from agricultural, coal and petroleum

products. Some of them are manufactured in reasonably large quantities, but they are inadequate to produce the huge tonnage of rubber used in the United States. For this reason and also because of its characteristics, 'Paracon' will probably remain a speciality product. The article gives some of the properties and uses of the material.

### *Portugaliae Physica*

A NEW Portuguese journal of physics, *Portugaliæ Physica*—the first of its kind in that country devoted entirely to physics—has been established and has published its first number. The four papers which it contains comprise a calculation of the matrix of electrostatic interaction and orbit-spin for $d^2p$ with an application to the spectrum of Ti II, a mathematical discussion of a group of operators with suggested application to quantum theory, and two papers on $\beta$-ray spectra with reference to internal conversion. In one of these, A. Gibert finds some evidence in support of Stahel's view that the energy quantum can be shared by more than one electron. At a time when the study of pure science has been necessarily replaced for so many by sterner pursuits, it is pleasant to realize that there are still countries where it is growing and needs new mediums for publication. Correspondence relating to the journal should be sent to *Portugaliæ Physica*, Faculdade de Ciências, R. da Escola Politécnica, Lisboa-Portugal.

### Libraries Board of South Australia

THE annual report of the Libraries Board of South Australia, covering the year July 1942–June 1943, refers to the opening on July 30, 1942, of new temporary accommodation for the country lending service, with a further great increase in the number of books issued, as well as to the rapid development of the research service. The latter is now receiving inquiries from every State in Australia for its lists of scientific and technical literature. Through the Scientific Liaison Bureau it is establishing relations between bodies carrying on similar work through the Commonwealth. The Board emphasizes the urgent need for building extension to cover the expansion of the research service, etc. During the year 4,615 books were added, making a total of 197,112 and in addition to 7,500 volumes in the Symon Library and 10,757 in the country lending service. The main library catalogue now contains about 541,648 cards.

### Earthquakes during March 1944

DURING this month eleven strong earthquakes were registered by the seismographs at the observatory at Toledo (Spain). The strongest to be recorded occurred on March 9, when *iPz* registered at 22h. 23m. 24s. from an epicentre some 62·5° distant; the earthquake attained a maximum amplitude at Toledo of 330 $\mu$ at 22h. 47m. 00s. The shock finished recording at 1h. 00m. 00s. on March 10.

At Wellington, New Zealand, during the same month, three strong earthquakes were registered by the instruments. These occurred on March 10, 22 and 31. In addition, eleven local earthquakes were felt in New Zealand during the month. The areas where these were reported as felt were Takaka, Nelson (March 15), Taupo (three times on March 20), Puysegur Point (on March 26), and Milford Sound (on March 29).

The United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has determined two more provisional epicentres during the month. The earthquakes occurred on March 22 and March 31. The former was recorded at both Toledo and Wellington, and the latter at Toledo. On March 22 the earthquake happened at 0h. 43·0m. G.M.T. and its epicentre, based on instrumental reports from eleven stations, was found to be at lat. 7° S., long. 126° E., which is in the Banda Sea. On March 31 the earthquake occurred at 20h. 34·8m. G.M.T., and on instrumental reports from Fordham, Philadelphia, St. Louis and San Juan the epicentre has been calculated to have been at lat. 3° S., long. 81° W., which is in Ecuador.

### Announcements

PROF. PETER KAPITZA has been awarded the Order of Lenin on the occasion of his fiftieth birthday, in recognition of his outstanding scientific achievements in physics.

PROF. W. P. WYNNE, emeritus professor of chemistry in the University of Sheffield, and a fellow of the Royal Society since 1896, has been elected a fellow of the Imperial College of Science and Technology, which he entered as a student sixty-three years ago.

THE Minister of Food has appointed Mr. Angus McKenzie, teacher of bread-making at the Royal Technical College, Glasgow, as a travelling bread adviser for Scotland. Any baker wishing to avail himself of Mr. McKenzie's services should either write to the Director of Bread, Bryn Euryn, Colwyn Bay, or Mr. McKenzie at his home address, 206 Cambusnethan Street, Wishaw.

AT the annual degree congregation of the University of Birmingham, the honorary degree of D.Sc. was conferred on Ernest Ansley Watson in recognition of his distinguished contributions to electrical engineering and, in particular, of his work on magnetos and on electric lighting of mines. The honorary degree of M.D. was conferred on Dr. Harry Guy Dain, Chairman of Council of the British Medical Association. The honorary degree of Master of Surgery was conferred on William Warwick James, in recognition of his eminent work on maxillo-facial injuries.

IT has been decided to postpone the conference on "The Nutritional Role of the Micro-flora in the Alimentary Tract", which the English Group of the Nutrition Society was to have held on July 22, at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1. An announcement concerning the revised arrangements will be made later.

THE Council of the Royal Society of Arts offers the following awards under the Thomas Gray Memorial Trust, the objects of which are "The Advancement of the Science of Navigation and the Scientific and Educational Interests of the British Mercantile Marine": a prize of £50 to any person of British or allied nationality for an invention, publication, diagram, etc., during the period January 1, 1939–December 31, 1944, which is likely to be of value in navigation; an award of £50 for a deed of professional merit by a member of the British Merchant Navy during the year ending September 30, 1944. Claims in connexion with both awards must reach the Acting Secretary, Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, before December 31, 1944.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Terrestrial Nemertines and Planarians in Britain

IN September 1943 I made a search for terrestrial planarians in the woods around the Yealm Estuary, South Devon. While doing so, a number of interesting organisms were brought to light.

(1) A terrestrial nemertine was found in the damper woods under fallen branches and later under stones and wood in damp situations in more open ground. It was commonly in company with the triclad *Rhynchodemus terrestris* and in places was numerous. It was found in widely separated places on both sides of the Estuary. The characters of this nemertine agree with those of *Geonemertes dendyi* Dakin.

The specimens were 5–15 mm. long and in general were of a yellowish colour with two brown longitudinal stripes on each side of the rhynchocoel. But the colour varied from almost white to orange, dark brown or even a purplish pink. The specimens possessed the arrangement of the eyes characteristic of the species, that is, two anterior groups of 4–6 eyes and two posterior groups of 3–5 eyes. The internal characters agree with those given by Hett[1] and Stammer[2]. Details of these will be published later. The only difference to be noted was in the number of proboscis nerves. Stammer gave the characteristic number of these as 14–15. Waterston and Quick[3] describe specimens with 13 proboscis nerves while my specimens commonly have 13 nerves, but sometimes 12 and in one case 11. In all the species of this genus, however, the number of proboscis nerves is variable, and in the two species closely related to *G. dendyi* their number is greater than 14. Of the many interesting anatomical features presented by these worms, the most outstanding is the nephridial system. The existence of this was mentioned by Stammer, but has not been described by him or by others. In my specimens the nephridial system shows the same peculiar characters as those in related species of the genus such as *G. hillii* Hett[4]. There are numerous small protonephridia immediately beneath the weakly muscular body wall. From each group of these a thin-walled duct leads to a long, coiled, glandular canal the cells of which have a very marked radial striation. This canal leads in turn to a duct opening to the exterior. These openings are very numerous. The glandular canals of my specimens are highly developed. They occupy well-defined lacunæ in the parenchyma and form conspicuous objects immediately beneath the muscle layer, particularly above and below the lateral nerve cords. The specimens that have been sectioned all proved to be females, but many were fertile and laid eggs which developed into young in about three weeks.

*G. dendyi* has been recorded three times. It was first described by Dakin[5] from a single specimen from Western Australia. Since in addition those species most closely related to it are confined to Australia, it is probable that the species is itself of Australian origin. Its subsequent history is remarkable. It was next found by Stammer in 1934 in greenhouses in Breslau. In 1937, it was recorded by Waterston and Quick in wild country near Swansea in Wales. It is now found apparently well established at places scattered round the Yealm Estuary in Devon. The possibility that it has been introduced into the northern hemisphere with some Western Australian plant suggests itself. An account of this organism will be published later.

(2) In company with *Rhynchodemus terrestris* were found at widely separated places round the Yealm Estuary a very few specimens of a Rhynchodemus clearly different from any recorded British species. It was some 6–10 mm. in length, of a brownish grey colour with two longitudinal purple brown stripes. Near the anterior end were two highly developed eyes with large lenses. The pointed snout is commonly carried a little upturned, giving the animal a somewhat ludicrous appearance of disdain. The organism is frail, and identification must await the collection of further specimens. In external characters, however, it agrees with Leidy's[6] description of the American species *Rhynchodemus sylvaticus* Leidy.

C. F. A. PANTIN.

Zoological Laboratory,
Downing Street,
Cambridge.
June 6.

[1] Hett, M. L., *Proc. Zool. Soc., Lond.*, 987 (1927).
[2] Stammer, H. J., *Zool. Anz.*, 106, 305 (1934).
[3] Waterston, A. R., and Quick, H. E., *Proc. Roy. Soc. Edin.*, 57, 379 (1937).
[4] Hett, M. L., *Proc. Zool. Soc., Lond.*, 775 (1924).
[5] Dakin, W. J., *Proc. Zool. Soc. Lond.*, 557 (1915).
[6] Leidy, J., *Proc. Acad. Philadelphia*, 5, 289 (1851).

## Birds and Butterflies

DURING a month's leave in the Anamalai Hills, Cochin State, South India, I have been studying the question of attacks by birds on butterflies. Both place and season (February–March) were well suited to such a study. The hills are covered by rain-forest, holding a rich fauna of insectivorous birds; and when I was there, shortly before the rains, some forty species of butterflies were on the wing, and some of these were common to abundance.

Take first the question of birds attacking butterflies in flight. Of insectivorous birds which take their insect-prey upon the wing, there were present: the large racquet-tailed drongo, bronzed drongo, wood shrike, paradise flycatcher (Tchitrea), several small flycatchers, broad-billed roller, chestnut-headed bee-eater (*M. leschenaulti*), spine-tailed swift, and the common Indian swift. I watched all these regularly, in the open glades, clearings and pathways which were the favourite haunts of butterflies; and I paid particular attention to the drongos, as being large, strong-flying birds, and a conspicuous feature in the jungle. *I did not see a single bird, of any species, catch or chase a butterfly.*

Two aspects of the question seem to me to have been all too little attended to. The first of these is the *time factor*. Jungle birds, like so many others, have their two main times of feeding and activity—early morning and late afternoon. While I was in the jungle, they started feeding about half-past seven and became idle about 10 a.m.; and then got to work again from about 4.30 p.m. until dusk. But the busy time for the butterflies was just the opposite; they were mostly on the wing in the middle of the day, from about 11 o'clock until four. Moreover, the butterflies seldom flew much higher than four

or five yards from the ground; while most of the insectivorous birds, especially the drongos, bee-eaters, rollers and swifts, feed twenty feet up at the least. There may be no hard and fast line here, but there is a clear and general tendency.

It was in these same hills that Mr. Salim Ali recorded[1] a huge hatch of "thousands upon thousands" of the large butterfly *Danais melissa dravidarum*, which were being taken on the wing by the ashy swallow shrike (*Artamus fuscus*). This bird I did not see. But Mr. Salim Ali notes that "*they were the only bird-species interested in these butterflies*", and concludes, from his observations elsewhere, that their food "seems to consist of butterflies to a very large extent".

Attacks by birds on butterflies not flying but at rest is the second part of my subject; and I found a good many more birds taking their insect-prey from trees and undergrowth than hawking it on the wing. Swifts, rollers and bee-eaters took no insects at rest, only those on the wing; all the others mentioned above took them at rest, and so did the other insect-eating birds, such as the babblers, warblers, white-eyes (Zosterops) and orange minivets; while bulbuls, mynahs and tree magpies were all partially insectivorous. It is not so easy to watch the feeding-habits of these birds as of those which take their prey upon the wing; but once again, my results were all completely negative—these birds ate no butterflies at all.

As to the ecological side of the question, most of the butterflies go to rest within small clumps of bamboo and other undergrowth, or occasionally in the inner foliage of evergreen trees. But only a few birds made these their usual feeding-places, such as the warblers and the white-eyes, both small birds with weak bills, and the babblers which are strong active birds; these latter roam the forest in bands or companies, and habitually search the dense thick undergrowth, the resting habitat of many butterflies. Thus the babblers would seem to be by far the most likely predators on butterflies (in addition to Artamus) in this region. But though I caught a number of butterflies, and paid particular attention to those with tattered wings, in no single case could I detect a trace of beak-marks on their wings.

C. R. STONOR.

South India.

[1] *J. Bombay N.H.Soc.*, 38, 315 (1935).

## Production of Mutations by Allyl *Isothiocyanate*

In the course of the past few years, we have examined a number of chemical substances for their ability to produce gene mutations. The experiments were carried out on *Drosophila melanogaster*. Some of the substances were found to be highly effective, producing mutation-rates of the same order as those obtained with X-rays, 6–24 per cent sex-linked lethals developing in treated $X$-chromosomes. These data will be published later.

Although the production of mutations by these potent synthetic substances is of great interest for the light it may throw on the nature of the gene and the process of mutation, the search for naturally occurring substances with the capacity to produce the same effect appears, from the point of view of evolutionary theory, even more important. It is therefore of special interest that among the substances tested we have found one, namely, allyl *iso*thiocyanate (mustard oil), which has a definite though slight effect on the mutation-rate, and which occurs naturally in a variety of plants, for example, *Brassica nigra* and other Cruciferæ (Klein[1]). A summary of the data on which this conclusion is based is given below. A full report will appear later.

The technique used was the *ClB* test for sex-linked lethals, which is the standard test used for detecting lethal mutations which develop in the $X$-chromosomes of the spermatozoa in treated (and control) males. Two experiments were carried out. With the second a control was done simultaneously on flies collected from the same culture bottles as the flies for treatment. The results are shown in the accompanying table.

| Expt. | No. of $X$-chromosomes tested | No. of lethals detected in the chromosomes | Lethals (per cent) |
|---|---|---|---|
| 1 | 756 | 17 (+1 doubtful) | 2·2 |
| 2 | 878 | 19 | 2·2 } Diff. = 15 ± 4·8 |
| Control | 963 | 4 | 0·4 } |

The difference between the treated and control series in the second experiment is clearly significant. Moreover, in both experiments the mutation-rate markedly exceeds the range of the spontaneous occurrence of sex-linked lethals in normal stocks, which scarcely ever reaches even 1 per cent.

In addition, three sex-linked visible mutations were obtained in the two treated series, none in the controls.

Experiments are under way to determine whether allyl *iso*thiocyanate can also produce chromosome breaks.

C. AUERBACH.
J. M. ROBSON.

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and Department of Pharmacology,
University of Edinburgh.
June 5.

[1] Klein, G., "Handbuch der Pflanzenanalyse", Part 2, Chapter 26 (Springer, Vienna, 1932).

## Increased Alkaloidal Contents of Induced Polyploids of Datura

TETRAPLOID plants of various species of Atropa, Datura and Hyoscyamus have been produced by the treatment of their seeds with colchicine solution; polyploidy being judged by the sizes of stomata or of pollen grains and by chromosome counts in root-tip preparations. Tetraploid plants of *Datura Stramonium* Linn. and *D. tatula* Linn. were healthy in appearance and produced as great a weight of dry leaf per plant as the diploid controls. Abundant viable seed was collected from them and produced $F_1$ and $F_2$ generations of tetraploids in the two following years.

Chemical determinations of the individual alkaloids *l*-hyoscyamine, atropine and hyoscine have been carried out on the dried leaves from diploid and tetraploid plants grown from seed of different origins. Results of assays, calculated with reference to the leaves dried at 100° C. for six hours, are shown in the accompanying table.

Analyses of $F_1$ and $F_2$ generations showed similar

| Seed stock | Diploid controls | | | | Tetraploid plants | | | |
|---|---|---|---|---|---|---|---|---|
| | Total alkaloid per cent | Percentage ratio of total alkaloid | | | Total alkaloid per cent | Percentage ratio of total alkaloid | | |
| | | Hyoscyamine | Atropine | Hyoscine | | Hyoscyamine | Atropine | Hyoscine |
| *Datura Stramonium* | | | | | | | | |
| A | 0·20 | 81 | 5 | 14 | 0·55 | 82 | 6 | 12 |
| B | 0·35 | 68 | 18 | 14 | 0·50 | 78 | 8 | 14 |
| C | 0·27 | 76 | 8 | 16 | 0·50 | 75 | 12 | 13 |
| *Datura tatula* | | | | | | | | |
| A | 0·24 | 83 | nil | 17 | 0·40 | 85 | nil | 15 |

alkaloidal contents to those of the parental tetraploid plants. The provisional conclusion may thus be drawn that the percentage total alkaloidal contents of tetraploid plants of *D. Stramonium* and *D. tatula* are approximately double those of the diploid plants; while the proportions of the individual alkaloids present remain unchanged.

Assays of tetraploid and diploid material from other species of Datura and from species of Atropa and Hyoscyamus are not yet completed. It is hoped to publish a detailed account of these researches when the results of the 1944 growing season have been obtained.

J. M. ROWSON.

Depts. of Botany and of Pharmacy,
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June 19.

## Relation of the Concentration of Vitamin A, Carotenoids and Cholesterol in Milk Fat to the Size of the Fat Globules

SOME time ago, Henry *et al.*[1], in measuring the vitamin A and carotene content of samples of fat churned or extracted by solvents from the same batch of milk, found that the concentration of vitamin A was the same in the fats prepared by both methods, but that there was slightly more carotene in the extracted fat. This they attributed to destruction during churning.

We have now obtained substantial evidence to show that this explanation is not correct, and that the small difference was due to the relatively high concentration of carotenoids in that fraction of the original milk fat which remained in the separated milk. We have carried out several experiments in which vitamin A and carotenoids were measured at the different stages of butter-making. In some of these experiments cheese was also prepared from the same bulk of milk and similar measurements were made on the whey, and at the different stages of butter-making from whey. Samples obtained during the separation by gravity of cream from milk were also examined. The results quoted in the accompanying table may be taken as an example. It shows that although the vitamin A was substantially the same in all fractions, the fat of separated milk contained seven times and the fat of separated whey eleven times as much carotenoids as the original milk fat. These two fractions consisted of the smallest fat globules which were not removed by two centrifugings in a dairy separator. The concentration of carotenoids in the fat of buttermilk and in the fat of whey was also higher than in the original milk, though the difference was very much less marked. Measurements showed that the size of the fat globules of these fractions was intermediate between that of the globules of the original milk and that of the separated milk. It will be seen that a very close correlation exists between the amounts of carotenoids and of cholesterol in the various fat fractions. Our values for cholesterol are of the same order as those reported by Frengley and Herrick[3] and by Ansbacher and Supplee[4] in similar fractionation experiments. Iodine values of the fatty acids prepared from the fats varied little, but were somewhat higher in the fats from separated milk and separated whey.

The difference in behaviour between vitamin A and carotenoids is very striking. The uniform concentration in which the former occurs in the different fat fractions suggests that it may be in true solution in the fat. The carotenoids and cholesterol, on the other hand, are present in greater amounts in those fractions in which the ratio of fat globule surface to fat is higher, and therefore may be associated in some way with the fat globule membrane.

Further work on these problems is in progress.

| Fraction | Method of extraction of fat | Fat (gm. per 100 ml.) | Vitamin A (I.U. per gm. fat) | Carotenoids (μgm. per gm. fat)** | Cholesterol (mgm. per gm. fat) | Iodine value of fatty acids | Average radius of fat globules (mean of 200 measurements) |
|---|---|---|---|---|---|---|---|
| Milk | Solvent* | 3·14 | 24·7 | 9·8 | 3·3 | 38·5 | 1·41 |
| Cream | Solvent* | 35·35 | 25·3 | 9·5 | 2·8 | 41·5 | 1·68 |
| Separated milk | Solvent* | 0·06 | 21·6 | 65·4 | 36·0 | 45·2 | 0·51‡ |
| Butter | Churning | 86·90† | 26·3 | 9·4 | 2·5 | 40·2 | — |
| Buttermilk | Solvent* | 1·98 | 24·2 | 12·2 | 6·0 | 42·3 | 0·89 |
| Whey | Solvent* | 0·42 | 23·2 | 14·9 | 5·6 | 37·8 | 1·09 |
| Whey cream | Solvent* | 18·20 | 24·7 | 9·4 | 3·3 | 40·2 | 1·80 |
| Separated whey | Solvent* | 0·03 | 26·2 | 111·0 | 46·0 | 48·0 | § |
| Whey butter | Churning | 83·90† | 26·3 | 9·3 | 2·7 | 40·1 | — |
| Whey buttermilk | Solvent* | 2·25 | 23·9 | 12·4 | 5·3 | 42·0 | 0·84 |

* The method was that of Olson *et al.*[2] slightly modified.
† gm. per 100 gm.
** The percentage of β carotene measured by chromatography did not vary greatly in the different fat fractions; the range was 74–82 per cent.
‡ Only 50 globules measured.
§ Owing to small size and scarcity of the fat globules, satisfactory measurement was not possible.

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[1] Henry, K. M., Kon, S. K., Gillam, A. E., and White, P., *J. Dairy Res.*, **10**, 114 (1939).

[2] Olson, F. R., Hegsted, D. M., and Peterson, W. H., *J. Dairy Sci.*, **22**, 63 (1939).

[3] Frengley, M. G., and Herrick, M. M., *Bull. N.Z. Dept. Sci. Indust. Res.*, No. 34 (1931).

[4] Ansbacher, S., and Supplee, G. C., *J. Biol. Chem.*, **105**, 391 (1934).

## Production of Penicillin

THE usual method adopted in the large-scale production of penicillin is to grow *Penicillium notatum* on shallow layers of modified Czapek-Dox media[1] at 24°C. for 10–12 days. The metabolic solution at the end of the incubation period has an activity of 3–4 'Oxford' units per c.c. This process involves handling large volumes of solution, and the space required is enormous. Moreover, the danger of contamination by penicillin-destroying bacteria during the lengthy incubation period is obvious.

Various attempts to shorten the incubation period and increase the yield of penicillin have been made; the more important ones are by Clifton[2] and by Srinivasa Rao and De[3]. The first one suffers from the difficulty of bacterial contamination. The second method using semi-solid media has been developed further in our laboratories.

Among the various semi-solid media tried by us, the best so far was found to be wheat bran. It provides the necessary loose physical structure facilitating aeration and also provides a large surface for growth of the mould. Maximum anti-*Staphylococcus aureus* activity was reached after 48 hours incubation. Addition of nutrients like yeast extract, etc., did not increase the yield of penicillin or shorten the incubation period. The procedure is briefly as follows:

30 gm. of wheat bran (particles of large size are preferable) are weighed out into 750 c.c. conical flasks, moistened with equal weight of water and mixed well. The flasks are plugged and autoclaved at 15 lb. pressure for one hour. The sterilized flasks are then inoculated with about 1 c.c. of a spore suspension of *Penicillium notatum*, well shaken and incubated at 24° C. for two days. The flasks are shaken once after 24 hours. This procedure gave consistently penicillin activity of 30 'Oxford' units per gram with Fleming's strain (N.C.T.C. No. 4222) tested by serial dilution method against *Staphylococcus aureus* Oxford. Another strain of *Penicillium notatum* has given us an activity of 150 units per gram.

The advantages claimed for the above process apart from low cost of manufacture are: (1) ease of handling semi-solid media; (2) consistent yields; (3) growth-time is reduced to two days, which is equivalent to increasing yield by five or six times; (4) the water extract of mouldy bran can be concentrated by using it for re-extraction with fresh mouldy bran to a fairly high potency; (5) bacterial destruction of penicillin is avoided; (6) large-scale methods used in the manufacture of taka-diastase can be used.

The concentrated crude extract is being used for local application to surface wounds with very good results.

My thanks are due to Drs. S. P. De and N. H. De for kind assistance and to Prof. V. Subrahmanyan for his keen interest in the work.

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[1] Abraham, Chain, *et al.*, *Lancet*, **241**, 177 (1941).
[2] Clifton, C. E., *Science*, **98**, 70 (1943).
[3] Srinivasa Rao, S., and De, S. P., *Cur. Sci.*, **12**, 209 (1943).

## Production of Ovulation by Fluoride *in vitro*

IN the course of an investigation on the action of enzyme inhibitors on pituitary-induced ovulation of the frog's ovary (*Rana pipiens*) *in vitro*, it was found that sodium fluoride would potentiate the pituitary effect. This unexpected result was considered as possibly associated with the binding of calcium by fluoride. Accordingly, the effect of other experimental procedures such as the use of calcium-free Ringer, oxalate, change in *p*H, etc., was investigated. A summary of the results together with probability values is shown in the accompanying table.

| Agent | Molar conc. | Pairs of ovaries | No. eggs extruded | | Value of *P* |
|---|---|---|---|---|---|
| | | | Treated | Control | |
| Sodium fluoride with pituitary | $10^{-2}$ | 4 | 2159 | 634 | $<0.01$ |
| Sodium fluoride without pituitary in calcium-free Ringer | $10^{-2}$ | 16 | 1699 | 1 | $<0.01$ |
| Sodium oxalate | $10^{-2}$ | 12 | 3630 | 3974 | $<0.05$ |
| Calcium-free Ringer | — | 8 | 1822 | 1031 | 0·05–0·01 |
| Ringer *p*H 5·6 (treated) and *p*H 7·4 (control) | — | 8 | 672 | 2593 | $<0.01$ |
| Sodium iodoacetate | $10^{-[illegible]}$ | 4 | 0 | 1766 | 0·05 |
| Sodium iodoacetate | $9\times10^{-5}$ | 4 | 395 | 1366 | 0·05—0·01 |

The procedures were similar to those previously reported[1]. Unless otherwise specified, the ovaries were removed and suspended in a total volume of 30 c.c. of buffered Ringer (*p*H 7·4) containing female frog pituitary together with the agent to be tested. Ovaries were studied in pairs, the left ovary serving as control for the right and vice versa. The total number of pituitary glands for the experiment was removed, finely macerated in 1–2 c.c. of distilled water, and taken up in a large volume of Ringer. The equivalent of two pituitary glands was then pipeted into a Petri dish into which one ovary was placed. Each experiment was allowed to run 31 hours, at the end of which time the ovaries were washed and the extruded eggs counted.

It is apparent (see table) that sodium fluoride potentiates the effect of pituitary in inducing ovulation and will, moreover, by itself cause egg release.

Fluoride may be considered to exert its action either through (1) a binding of calcium, or (2) an inhibition of some portion of the respiratory or glycolytic mechanisms. Chambers[2] found that calcium is necessary for the stability of the intercellular cement of capillaries and kidney tubules; and when the calcium of the cement substance is decreased by using calcium-free solutions or lowering the *p*H, it becomes loosened. Loosening of the intercellular cement could be expected to favour ovulation by permitting a more ready rupture of the cell layers surrounding the egg. While the results with fluoride and calcium-free Ringer might be interpreted on this basis, the oxalate and *p*H experiments apparently do not support such a view.

With respect to the action of fluoride on glycolysis, one may postulate that the accumulation or deficiency of a particular intermediate substance or substances initiates processes which result in ovulation. The relatively high concentration of fluoride ($10^{-2}$ *M*) may well inhibit respiration as well as glycolysis. Inhibition

of the glycolytic mechanism as a whole, however, does not satisfactorily explain the fluoride effect, inasmuch as iodoacetate, which produces the opposite effect to fluoride on ovulation, also inhibits glycolysis[3]. Oxalate, which is without significant effect on ovulation, may also inhibit glycolysis under certain conditions, but is without effect on living yeast, presumably because of its failure to penetrate[4].

We have been obliged to discontinue these experiments temporarily owing to the advent of the season of spontaneous ovulation in our frogs.

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[1] McPhail, M. K., and Wilbur, K. M., *J. Pharmacol. and Exp. Therap.*, **78**, 304 (1943).
[2] Chambers, R., Cold Spring Harbor Sympos., **8**, 144 (1940).
[3] See chapter by Cohen, P. P., "Respiratory Enzymes" (Minneapolis, 1939).
[4] Runnström, J., and Hemberg, T., *Naturwiss.*, **25**, 74 (1937).

## Treatment of Blackwater Fever

HÆMOLYTIC substances were demonstrated in the peripheral blood of three patients. They appear a few minutes before an attack of hæmoglobinæmia and are rapidly removed from the serum by the red blood cells. The hæmolytic properties of the serum can be preserved if the red blood cells are rapidly removed by centrifuging[1].

The hæmolytic process is accentuated by quinine (1 in 300), pamaquine (1 in 1,000) and mepacrine (1 in 500) and antagonized by antivenine (1 in 300); antivenine also antagonizes the action of drugs.

The clinical use of antivenine has been attended with complete success. 200 ml. initially, followed by 10 ml. at intervals of four hours, completely cut short an attack of blackwater fever in thirty-six cases, in which the mortality ordinarily would have been 25–50 per cent. Furthermore, in three cases, the administration of mepacrine in full doses together with antivenine cured the blackwater fever together with the causative malignant malaria.

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[1] Singh, I., and Singh, I., *Ind. Med. Gaz.* (in the Press).

## Structure of Cellulose

IN a recent communication[1], Peirce has put forward considerations on the structure of cellulose based on a pyranose ring in which the five carbon atoms are nearly co-planar and there is a right angle between the bonds of the ring oxygen. We should like to say that to invoke such a configuration is unnecessary and unjustified by the evidence. To be sure, a flat or flattish ring was long current in the X-ray literature on cellulose[2], but it was never easy to see the real need for it, and latterly Meyer and Misch[3] have stated that the X-ray intensities support the 'armchair' ring equally well and have gone over to that form.

Contrary to what Peirce suggests, the *trans*-, or armchair, form of the Sachse strainless ring does give the observed fibre period of cellulose very closely ($10{\cdot}3_7$ A. as compared with $10{\cdot}3_0$ A.), if one takes 1·54 A. for the length of the C–C bond and 1·42 A. for the C–O bond, with the tetrahedral angle for the carbon inter-bond angle and 110° for the oxygen inter-bond angle[4]. Our own immediate interest in the matter arises from an X-ray study of the structure of alginic acid and its relation to that of cellulose and its derivatives. To reproduce quite accurately the characteristic dimensional features of these two different chain configurations (and probably of pectin also), we have not yet found any necessity either for going outside such concepts of sugar chemistry as have been built up particularly by Haworth, Hirst and their collaborators, or for departing seriously from accepted bond-lengths and angles derived from simpler compounds; and full-scale models, also, that we have constructed of regenerated cellulose are satisfactory in these respects.

In support of his proposals, Peirce cites the earlier work of Cox and his collaborators: their later work, however, goes far to establish the strainless armchair ring. Cox and Jeffrey on glucosamine hydrobromide[5], for example, go almost all the way; but perhaps the most convincing evidence is found in an X-ray investigation by Cox and Brown[6] of the crystal structure of β-methyl xyloside. Here a three-dimensional Patterson synthesis reveals only three vectors of length approximately 1·5 A., and there is only one form of the xyloside molecule that is compatible with such a result, namely, the strainless armchair. The same shape of molecule provides also what appears to be a unique explanation of the observed intensities of reflexion from the ($30\bar{4}$) and (402) planes.

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[1] Peirce, F. T., *Nature*, **153**, 586 (1944).
[2] For example, Meyer and Mark, "Der Aufbau der hochpolymeren organischen Naturstoffe" (1930).
[3] Meyer, K. H., and Misch, L., *Helv. Chem. Acta*, **20**, 232 (1937).
[4] Pauling, "The Nature of the Chemical Bond" (1939).
[5] Cox, E. G., and Jeffrey, G. A., *Nature*, **143**, 894 (1939).
[6] Brown, C. J., Ph.D. thesis, University of Birmingham (1939).

IT is not stated whether the new structure for cellulose proposed by Dr. F. T. Peirce[1] is in better agreement with the X-ray intensities than those previously put forward; but as some justification for it is sought in the earlier work of the Birmingham school, the following observations may be relevant. These observations are of a somewhat general character as the records of my unpublished work are not at present at hand.

At the time the paper[2] quoted by Peirce was written, X-ray technique was insufficiently advanced for detailed analyses of individual saccharides to be made, and the views advanced as to the conformation of the pyranose ring were based on a general survey of a large number of compounds. In the light of more recent work, it seems probable that as the molecular arrangement in polyhydroxy compounds is determined largely by the distribution of OH groups, whereas that in methylated sugars depends chiefly on general molecular shape, deductions from a survey covering both types are not so con-

clusive as they appeared in 1935. Later work (for example, ref. 3, but chiefly unpublished) has included very detailed analyses in which atomic positions have been fixed to rather better than 0·1 A., and within this limit there is no evidence that the pyranose ring departs from the Sachse *trans* conformation; this is not to say that I believe that small deviations from exactly tetrahedral bond angles are necessarily excluded or indeed improbable, but since the possible combinations of deviations are so numerous, it would seem to be advisable to restrict speculations on the structure of cellulose to tetrahedral configurations until experimental evidence requires some departure from them.

While I believe that the structure of cellulose will best be determined, as suggested by Peirce, by combining the knowledge of atomic arrangements found in crystalline oligosaccharides with the less detailed information obtained from cellulose itself, it must be emphasized that the assignment of atomic parameters in cellulose with an accuracy of 0·01 A. is at present entirely speculative[4], since the most detailed saccharide crystal analysis so far reported[3] gives atomic positions only to about 0·08 A., and the data from cellulose itself certainly do not justify any higher accuracy.

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[1] *Nature*, **153**, 586 (1944).
[2] Cox, Goodwin and Wagstaff, *J. Chem. Soc.*, 1495 (1935).
[3] Cox and Jeffrey, *Nature*, **143**, 894 (1939).
[4] Cf. Cox, *Ann. Rep. Chem. Soc.*, **34**, 194 (1937).

## Thermodynamics of Friedel-Crafts Reactions

SINCE the time of Gustavson[1] and Menschutkin[2] it has been known that salts of the $AlCl_3$ type can give stable complex compounds with certain classes of organic compound.

We have measured the heats of formation from the salt plus organic liquid of a number of these complexes. A Dewar-vessel calorimeter was used, and the results were corrected for spurious heat effects, such as those arising from chemical reactions other than complex formation. In some cases the heats are surprisingly large, and, neglecting entropy effects, it has seemed reasonable to us to ascribe an important role in these cases to the complex-formation stage, in controlling the course and products of the reaction.

For example, consider the two reactions below

$COg + C_6H_6l = C_6H_5CHOl$ . catalysed by 1 mole of $AlBr_3$ . . . . . . . . . . . . . (1)

$nCH_3Clg + C_6H_6l = C_6H_{6-n}(CH_3)_nl + nHCl$ catalysed by a small amount of $AlCl_3$ . . . . (2)

Calculation from heat of combustion and entropy data yields values of $\Delta G^\circ$ for both reactions in the neighbourhood of zero (restricting ourselves to the case $n = 1$, 2 and 3 in reaction 2). There is an uncertainty in the heats of combustion which gives an error of perhaps $\pm 1$ kcal. in case 1, and a possibly larger error in reaction 2, due to the uncertain data for $CH_3Clg$. This uncertainty is not likely to affect the point we wish to make.

In both cases no stable complex is formed between the catalyst and the reactants, and we are concerned with the products only. Considering reaction 1, we have found that the heat of formation of the complex $AlBr_3(C_6H_5CHO)_x$ is 30 kcal. per mole of aluminium bromide. It therefore seems reasonable to suggest that this complex-formation, by making the overall free energy of reaction strongly negative, plays a large part in ensuring the excellent yields normally obtainable in this reaction[3].

Our calculation for reaction 2 would suggest that, complex formation apart, none of the possible products toluene, xylenes, trimethylbenzenes should be specially favoured on thermodynamic grounds. This view is supported by the observations of Boedtker and Halse[4], on the reversibility of this reaction, carried out under normal liquid-phase conditions. However, we find that the heats of complex formation are $AlCl_3$/xylene 22 kcal.; $AlCl_3$/mesitylene 8 kcal.; and $AlCl_3$/toluene 0 kcal. Clearly, we should expect the preferential formation of the $AlCl_3$/xylene complex, and this in fact may be found under special conditions. If methyl chloride gas is passed over aluminium chloride in a vertical catalyst tube, xylene is preferentially obtained as the $AlCl_3$/xylene complex. This drips from the tube, leaving a fresh aluminium chloride surface. On the other hand, if the xylene/$AlCl_3$ complex be retained in the sphere of action by using a horizontal catalyst tube, appreciable yields of toluene may be obtained. In this latter case, similar to the usual liquid phase conditions, the xylene/$AlCl_3$ complex is formed initially, and then itself functions as a catalyst.

It is well known that the quantity of 'catalyst' used plays an important part in Friedel-Crafts syntheses; for example, whereas reaction 2 needs only small amounts, reaction 1 requires a molar quantity. Our work would suggest that two conditions determine this quantity: first, whether complex formation is necessary to make the reaction thermodynamically favourable; secondly, if a complex is formed, whether it is catalytically active. In the quantitative investigation of any particular synthesis, both factors require consideration. Equilibrium constants obtained by using catalysts of the type of aluminium chloride must be suspect unless they have been shown to be independent of catalyst concentration (for example, Pitzer's work on the xylene plus benzene reaction[5]).

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[1] Gustavson, *J. Prak. Chemie*, **68**, 209 (1903); **72**, 57 (1905).
[2] Menschutkin, *Chem. Abs.*, **3**, 1487 (1909); **5**, 1434 (1911).
[3] Reformatsky, *Chem. Zent.*, (i), 1226 (1901); (ii), 1372 (1901).
[4] Boedtker and Halse, *Bull. Soc. Chim.*, **19**, 444 (1916).
[5] Pitzer and Scott, *J. Amer. Chem. Soc.*, **65**, 803 (1943).

## Reabsorption of Electrolytes in the Renal Tubules

REABSORPTION of electrolytes in the renal tubules has been examined for phosphates by Harrison and Harrison[1] and Smith, Ollayas and Winkler[2] in the dog, and by Barclay, Bray and Cooke[3] in man, and for chlorides by Hare, Hare and Phillips[4].

An examination of the available data at this stage may provide indication for future work and perhaps a basis for some standard system of imparting results.

We are in agreement with Harrison and Harrison[1] that the reabsorption of phosphates is directly related to glomerular filtration: if the glomerular filtration rate is plotted against the rate of phosphate reabsorption, the points fall along a straight line passing through the origin. We consider, therefore, that it is permissible to select any point on this line and use it as a reference point. The rate of glomerular filtration of 100 c.c. per minute is, we believe, convenient for two reasons: plasma values are usually expressed to 100 c.c. and, secondly, 100 c.c. would appear to be fairly close to the more recent determination of the average rate of filtration in man. On this basis, we find that the tubular reabsorption of phosphate, using a standard technique, is practically constant, but that alterations in technique do result in a different rate of reabsorption.

In the experiment of Hare *et al.*[4], we have plotted the rate of chloride reabsorption against filtration-rate, finding a straight-line relationship. Determination of the rate of chloride reabsorption per 100 c.c. glomerular filtrate shows that this is once more practically constant as is the case with phosphate; the plasma level would appear to have no influence on the rate of absorption. This is perhaps even more evident if one plots the ratio of chloride absorbed per 100 c.c. glomerular filtrate to plasma chloride, instead of the ratio used by the authors. Thus plotted, their Fig. 2 is considerably altered; 2·5 per cent sodium chloride falls well below 0·5 and 0·6 per cent sodium chloride. This is merely another expression of our point that a rise of plasma chloride does not affect the rate of reabsorption. If a similar procedure is adopted in the case of their Fig. 3, it is at once evident that pituitrin has no effect upon the rate of tubular absorption of chlorides. Hare *et al.* noted that if glomerular filtrate was increased, the reabsorption of chloride is increased; when they state that they can find no upper limit to the threshold, they merely indicate that the tubules are able to cope with the increased chloride provided by the increased filtration to limits set by the inability of the organism to tolerate further increase of sodium chloride. When they state that they are unable to find a threshold value for chlorides, we would point out that the threshold, expressed as a rate of tubular reabsorption per 100 c.c. glomerular filtrate, is in the neighbourhood of 380 mgm. per 100 c.c. The reason for the increased excretion of chlorides during the glycosuria experiments would appear to be the lowering of the chloride threshold to 330 mgm. per 100 c.c. If one uses the method of ratios, when the reabsorption per 100 c.c. glomerular filtrate to the plasma value is less than one, then the threshold has been exceeded.

The use of percentage chlorides reabsorbed is preferred by Hare *et al.* rather than the absolute amount reabsorbed, presumably because they feel that the percentage is more constant than the absolute amount. This is, of course, a point of fundamental importance from the point of view of renal function. We have indicated above our reasons for preferring absolute amounts, but perhaps further examination will clear the way to future discussion. Evidence against a constant percentage absorption of chlorides is provided by the authors' own ratios. In the dogs with diabetes insipidus, the ratio is high; on administration of pituitrin, the ratio falls. Careful consideration of the figures indicates that the difference in the ratios is due to the fact that while the diabetes insipidus dogs are reabsorbing less water, they are, as we pointed out, reabsorbing the same amount of chloride, and therefore the percentage of chloride must be high and so must be the ratio. If the percentage of chloride reabsorbed remains constant, then the excretion of chloride will vary directly with the volume of urine; if the absolute amount remains constant, then excretion will vary directly with the plasma chlorides. Since Hare *et al.* point out that even when plasma chloride has fallen considerably, chloride is still present in the urine, and Smith[5] also makes the same point, perhaps it is as well to indicate the conditions which must be fulfilled if the urine is to become chloride-free. If the amount of chloride reabsorbed per 100 c.c. glomerular filtrate is the same as the plasma chloride, the urine will be free at all filtration-rates and all urine volumes; if the percentage of chloride is constant, then urine will be chloride-free only for a certain definite percentage (higher than the plasma value), and for a certain definite filtration-rate and urine volume.

In either hypothesis the variability of the factors involved makes the likelihood of obtaining a chloride-free urine very small indeed.

To summarize, we believe that the electrolytes, at any rate those so far examined, have a definite threshold, but this threshold is not fixed once and for all, but, save under rigidly standard conditions, varies from time to time, probably under the influence of hormone balance. It does not appear to vary with the level of the electrolyte in the blood, although Smith, Ollayas and Winkler[2] have demonstrated an effect on threshold when the plasma-level is outside the normal physiological range. Lastly, the excretion of electrolytes, like that of water, is practically independent of rate of glomerular excretion; and the tubule cells have apparently no upper limit to the amount they can reabsorb from an increasing glomerular filtration.

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[1] Harrison, H. E., and Harrison, H. C., *J. Clin. Invest.*, **20**, 47 (1941); *Amer. J. Physiol.*, **134**, 78 (1941).
[2] Smith, P. K., Ollayas, R. W., and Winkler, A. J., *J. Clin. Invest.*, **22**, 143 (1943).
[3] Barclay, J. A., Bray, H. G., and Cooke, W. T., *J. Physiol.* (in the Press).
[4] Hare, R. S., Hare, K., and Phillips, D. M., *Amer. J. Physiol.*, **140**, 334 (1943).
[5] Smith, H., "Physiology of the Kidney" (New York, 1937).

## Permanence and Stability of Emulsion Systems

THE terms 'permanence' and 'stability' have often been regarded as synonymous when applied to emulsion systems. Until recently, neither term had a sufficiently rigid significance. In 1939, King and Mukherjee[1] defined the stability of an emulsion system as the reciprocal of the rate of change (with respect to time) of interfacial area, per unit area of initial emulsion interface. In this connexion the term 'specific interfacial area' ('specific surface', 'specific interface') may be expressed as being the number of square decimetres of interfacial area per gram of the dispersed liquid. These authors assumed that the rate of change of specific surface of an oil-water

emulsion is proportional to the initial specific surface (although in later work[2] they found that there appeared, in some cases, to be two rates, an initial rapid change, followed by a slower change), that is, according to the simpler assumption,

$$-\frac{ds}{dt} = k_1 s_1 = \frac{s_1}{k},$$

where $s$ is specific surface; $s_1$ is initial specific surface; $t$ is time; $k_1$ is instability factor; $k$ is stability factor.

It will be observed that $k$, here, has the dimension of time. King and Mukherjee developed a method, based on the size-frequency analysis of the given emulsion system after various time-intervals, for the evaluation of $k$.

Lotzkar and Maclay[3] determined the comparative efficiencies of certain emulsifying agents by the application of a size-frequency technique to the emulsions formed using these agents, but the formula used in calculating the stability factor ($k$) of the emulsions was modified to:

$$-\frac{ds}{dt} = k_1 s = \frac{s}{k}.$$

In this formula also, $k$ has the dimension of time.

In many technical processes emulsions are required to withstand such mechanical stresses as those imposed by shaking, vibration, centrifuging, temperature-change, impact, etc.

It is conceivable that where precaution is taken against the submission of the system to undue mechanical or other disturbance, an emulsion might display a high degree of permanence inasmuch as that comparatively little deterioration might occur on ageing; whereas if it were subjected to some disturbance rapid deterioration might set in.

Such a system (a water-oil emulsion, sponsored by Mona wax) is described by Aherne and Reilly[4]. The emulsion, "a water-in-liquid-paraffin system", showed good permanence inasmuch as that no gross deterioration could be observed when it had aged for months, but even the most cautious addition of a light cover-glass to a sample of the emulsion (suitably diluted) on a microscope slide caused immediate coalescence of the water-globules of the sample in 'pools'. It is therefore questionable whether the terms 'stable' and 'stability' could, even in the ordinary restricted sense (since de-emulsification is, in the thermodynamic sense, an irreversible process), be applied to a system unable to withstand such slight mechanical disturbance. If the factor obtained as a result of size-frequency analyses at various time-intervals (precaution being taken against the submission of the system to undue mechanical disturbance) be called, in the case of such a system, a 'stability factor', the figure might be very misleading. It has been suggested, therefore, that the factor $k$ (above) might, when the precaution aforementioned is taken in its determination, be termed a 'factor of permanence'.

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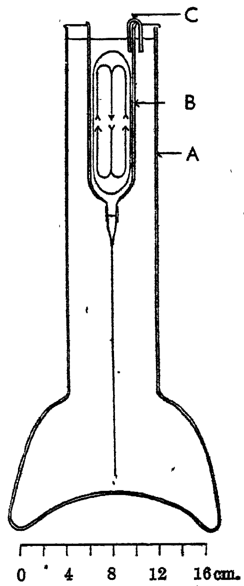
[1] King and Mukherjee, *J. Soc. Chem. Ind.*, 58, 243 (1939).
[2] King and Mukherjee, *J. Soc. Chem. Ind.*, 59, 185 (1940).
[3] Lotzkar and Maclay, *Ind. and Eng. Chem.*, 35, 1294 (1943).
[4] Aherne and Reilly, *Sci. Proc. Roy. Dubl. Soc.* (1944) (in the Press).

## An Apparatus for Low-Temperature Dialysis

BOTH speed and low temperatures are highly desirable in the dialysis of sensitive protein solutions. Unfortunately, when small refrigerators are used instead of cold rooms, the apparatus used to increase the velocity of dialysis has to be sacrificed to space requirements. For example, the Kunitz[1] dialyser, in which a stream of pure water is allowed to flow over a rocking dialysis sac containing a marble, cannot be set up in an ordinary laboratory refrigerator.

If a dialysis sac containing a salt solution is suspended in water, the greater density of the solution dialysing out causes it to flow downwards, and currents can be seen streaming away from the bottom of the sac. In the dialyser described below, an attempt has been made to utilize this fact to set up a circulation which results in a constant supply of fresh water to the outside of the dialysis sac. The apparatus consists of a tall dialysis vessel $A$ of about 7·5 cm. diameter by 40 cm. high containing a second flow-directing vessel $B$ about 15 cm. total length by 3·5 cm. in diameter ending in a jet. The dialysis sac is placed in the inner vessel, and the water in the inside and outside vessels connected by a syphon $C$ of approximately 2 mm. bore.




The flow of the denser salt-containing fluid out through the jet can be easily followed either by direct observation or by placing a flash-lamp bulb on one side of the vessel about 1 ft. away and a sheet of paper on the other side at a similar distance, when a Schlieren picture of the stream will be projected on to the paper. The fine stream of fluid from the jet passes almost to the bottom of vessel $A$ without breaking up, and even after it has broken up the fragments continue on their way downwards. This flow results in the dense salt solution collecting at the bottom of vessel $A$, while fresh water is being continuously supplied around the dialysis sac. The process lasts for 24–48 hours, depending on the initial volume and concentration of the dialysing fluid, and continues until the salt solution has risen to the level of the jet.

Simultaneously, another circulation is taking place inside the sac. It can be observed by watching the movement of small particles of dust, etc., just inside the membrane, where the fluid, owing to loss of salt, rises slowly, while that in the centre of the sac falls, resulting not only in mixing inside the sac but also in the maximum differential salt concentration being developed across the membrane due to the counter current principle. The flow of fluid inside and outside the membrane also helps to abolish skin effects which restrict diffusion due to stagnant surface layers.

The dimensions of the apparatus, especially height of vessel $A$ and jet size, play an important part in efficiency. We have not observed unbroken flow

streams of more than 20 cm. from jets used, and it therefore seems that no great increase in efficiency would result from making the apparatus any taller. The optimum diameter of the jet appears to be about 0·4 mm.

The dialysis time for a 0·5 saturated ammonium sulphate solution under these conditions is about thirty hours, and the final concentration inside the sac is approximately 1/500 of the initial concentration, that is, of the order of 0·1 mgm. nitrogen/c.c. This dilution corresponds to 1/12 of the concentration that would occur if all the salt in the sac were to be evenly distributed throughout the whole volume of the dialysate.

To avoid salt contamination of the water in the outside vessel, the apparatus is set up as follows. The dialysis sac is placed inside vessel *B*, and *B* is then lowered into *A*, which already contains the approximately correct volume of water. When the inside and outside levels are the same, the syphon is filled and dropped into place.

The term 'gravity dialyser' is suggested for the apparatus.

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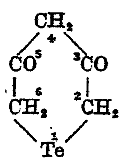
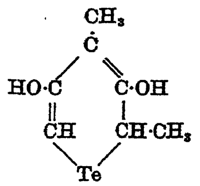
[1] Kunitz, M., and Simms, H. S., *J. Gen. Physiol.*, **11**, 641 (1928).

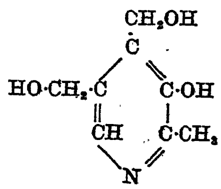
## A Speculation on the Bactericidal Activity of certain Tellurium Compounds

THE intense bactericidal activity of *cyclo*telluropentane-3 : 5-dione (I) and some of its homologues was reported by Morgan and his collaborators[1–4]. This property is shared only to a limited extent by other tellurium compounds; it is not due to the lability of tellurium in this ring, since conversion of (I) into its equally labile dioxime causes a marked drop in bactericidal power (see table). The theory of substrate competition[5] provides a rational explanation of the activity of this group of compounds. The formula of one of the highly active members, 2 : 4-dimethyl-*cyclo*telluropentane-3 : 5-dione (II), bears a striking resemblance to that of pyridoxine (III), which is known to be a growth-factor for many species of micro-organisms[6–8], and it seems to us possible that the relation between the two substances may be similar to that between *p*-amino-benzoic acid and sulphanilamide[9,10].

In the present circumstances, we are unable to test this hypothesis experimentally; but the following facts may be adduced in its support, the data on *B. coli communis* being drawn from the table. Similar results are available[2] from experiments on *B. typhosus*, *Staph. pyogenes aureus* and *Strep. hæmolyticus*.


(I)


(II)


(III)

(i) The bactericidal effect requires the presence of an enolic hydroxyl group in the 3-position of the *cyclo*-telluropentane-3 : 5-dione ring. When enolization is prevented (the dioxime) or inhibited (the 4 : 4-diethyl compound) the effect is less marked. A hydroxyl occurs in the corresponding position of the pyridoxine molecule.

(ii) The bactericidal effect is sensitive to the nature and position of substituents in the *cyclo*-telluropentane-3 : 5-dione ring. The 1 : 1-dihalides are inactive and the strongly polar 4-chloro-compound has only very weak activity. Unsubstituted *cyclo*telluropentane-3 : 5-dione is moderately effective, but the introduction of small alkyl groups (methyl or ethyl) in the 2-position greatly enhances the bactericidal power; larger alkyl groups (propyl, butyl or amyl) are less effective. A methyl group in the 2-position characterizes the pyridoxine molecule.

Pyridoxine bears an alkyl substituent in the 4-position, and 4-alkylated derivatives of *cyclo*-telluropentane-3 : 5-dione are considerably more active than the parent substance. The 2 : 4-dimethyl compound is second equal in activity in the series which was tested.

If the arrangement N.C($CH_3$).C(OH).C may be regarded as of fundamental bacteriological significance in the pyridoxine structure, it should be noted that the most active tellurium derivatives tested, 2 : 6-dimethyl and 2 : 6-diethyl *cyclo*telluropentane-3 : 5-dione, contain this arrangement twice, nitrogen being replaced by tellurium.

| Compound | Mean effective concentration |
|---|---|
| *Cyclo*telluropentane-3 : 5-dione (CTPD)[2] | 1 in 500,000 |
| CTPD-3 : 5-dioxime[4] | 1 in 166,000 |
| 4 : 4-Diethyl CTPD[2] | 1 in 900,000 |
| 4-Chloro-CTPD[11] | 1 in 12,500 |
| 2-Methyl CTPD[2] | 1 in 3,000,000 |
| 2-Ethyl CTPD[2] | 1 in 3,000,000 |
| 2-Propyl CTPD[2] | 1 in 1,200,000 |
| 2-Butyl CTPD[2] | 1 in 700,000 |
| 2-Amyl CTPD[2] | 1 in 500,000 |
| 4-Methyl CTPD[2] | 1 in 900,000 |
| 4-Ethyl CTPD[2] | 1 in 2,500,000 |
| 4-Butyl CTPD[2] | 1 in 2,800,000 |
| 2 : 4-Dimethyl CTPD[2] | 1 in 5,000,000 |
| 2 : 6-Dimethyl CTPD[2] | 1 in 9,000,000 |
| 2 : 6-Diethyl CTPD[2] | 1 in 5,000,000 |

Should our general hypothesis be correct, it seems possible that compounds related to *cyclo*telluropentane-3 : 5-dione, but containing oxygen or sulphur instead of tellurium, might have correspondingly high bactericidal or bacteriostatic properties without the alarming toxicity which makes *cyclo*telluropentane-3 : 5-dione itself quite impossible for therapeutic use.

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May 7.

[1] Morgan, Cooper and Burtt, *Biochem. J.*, **17**, 30 (1923).
[2] Morgan, Cooper and Burtt, *Biochem. J.*, **18**, 190 (1924).
[3] Morgan, Cooper and Corby, *J. Soc. Chem. Ind.*, **43**, 304 *T*(1924).
[4] Morgan, Cooper and Rawson, *J. Soc. Chem. Ind.*, **45**, 106*T* (1926).
[5] Fildes, *Lancet*, **238**, 955 (1940).
[6] Möller, *Z. physiol. Chem.*, **254**, 285 (1938).
[7] McIlwain, *Brit. J. Expt. Path.*, **21**, 25 (1940).
[8] *Ann. Rev. Biochem.*, **9**, 400 (1940); **10**, 352 (1941); **11**, 326 (1942); **12**, 554, 557 (1943).
[9] Woods, *Brit. J. Expt. Path.*, **21**, 74 (1940).
[10] *Ann. Rev. Biochem.*, **12**, 561 (1943).
[11] Calculated from data of Morgan and Drew, *J. Chem. Soc.*, **121**, 922 (1922).

# RESEARCH ITEMS

## Carbohydrate Metabolism after Burns

IT is well known both in man and animals that there is a rise in the level of blood sugar during the first few hours after a burn. E. J. Clark and R. J. Rossiter (*Quart. J. Exp. Physiol.*, 32, 269 and 279; 1944) have studied the changes in carbohydrate metabolism produced by experimental skin burns in rats and rabbits. During the first three hours following a burn there is hyperglycæmia, rise of blood lactate, decrease of muscle glycogen, and either no change or a decrease in liver glycogen. The increased blood sugar comes chiefly from the muscle glycogen via the liver (Cori cycle). All these changes, except for the liver glycogen, could be reproduced by injection of adrenaline into normal animals. Injection of adrenaline into rats and rabbits always causes a rise of liver glycogen. Further, it was shown that liver slices from the burned animals formed glycogen from glucose (*in vitro*) much less readily than did liver slices from normal animals, whereas liver slices from adrenaline-injected animals formed glycogen normally. The authors conclude that the changes are mainly due to the liberation of adrenaline, but that in addition there must be some other factor acting on the liver, either accelerating glycogen breakdown or inhibiting its synthesis. Results of other workers suggest that some factor in addition to adrenaline is also at work in the hyperglycæmias of hæmorrhage and asphyxia. There is no clue as to what the additional factor may be, but it is probably common to burns, hæmorrhage and asphyxia.

## Spanish Mackerel

CAPTAIN IAN S. R. MUNRO has published a most useful work in his "Revision of Australian Species of Scomberomorus" (*Mem. Queensland Mus.*, 12, Part 2; Nov. 1943). The Spanish mackerel comprise an important group of deep-sea food fishes which support a valuable coastal pelagic fishery in Australian waters, particularly Queensland, northern New South Wales and Western Australia. The industry is based primarily on the barred Spanish mackerel *Scomberomorus* (*Cybium*) *commerson*, caught by trolling in coastal waters, but there is a small net fishery of *Scomberomorus* (*Cybium*) *queenslandicus* sp. nov., which enters the estuaries along the coast during the winter months. Several other marketable species are caught in smaller numbers. All these, like their relatives from overseas, are first-class food fishes, and the larger forms provide good sport for game anglers along the coast of New South Wales and the Great Barrier Reef. A decline in the annual catches in spite of improvement in technique and equipment is due partly to a large increase in fishing activities during the spawning seasons. Investigations concerning the biology and economics are in progress, and the present work deals with the exact diagnosis and subsequent identification of all species. Four species are shown to occur in Australian seas. All members of the family are coastal inhabitants, and throughout the world they are seldom found in water deeper than forty fathoms. Some migrate into estuarine waters at certain seasons. Most of the species inhabit the clear tropical waters of ocean currents around rocky islets and coral reefs, tide rips and off-shore currents. Their preference for waters of low density and medium salinity apparently accounts for their coastal distribution. Good figures of the Australian species are given.

## Carbon Dioxide as a Measure of Grain Infestation

R. W. Howe and T. A. Oxley of the Pest Infestation Laboratory at Slough discuss a method intended to give at least an approximate measure of insect infestation of grain in a short time. In this connexion it was thought that the rate of carbon dioxide production of infested grain, as a measure of metabolism, would probably be a satisfactory measure of infestation. The very different methods in use are either laborious or consume a great deal of time. While the carbon dioxide method gives less detailed information than the existing and more laborious methods, it has the great advantage over them of giving an estimate of the actual amount of damage which an infesting population is causing. The authors describe (*Bull. Entomol. Res.*, 35, 11; April 1944) a detailed technique for the routine determination of the carbon dioxide output of samples of grain. The carbon dioxide figure obtained is largely a measure of insect infestation of the sample of grain tested, and a table is given by which the numbers of various species of grain infesting insects may be estimated from the carbon dioxide figure. Clean grain of less than 15 per cent water content produces up to 0·25 per cent carbon dioxide in twenty-four hours at 25° C., so that results up to 0·3 per cent are considered to indicate clean grain. A result between 0·3 and 0·5 per cent indicates slight infestation or a water-content of more than 15 per cent. Grain showing a carbon dioxide content of 1 per cent or more indicates that it is highly unsuitable for storage. In such a sample this is an indication of an infestation of one Calandra weevil larva per 500 grains or 33 larvæ per pound.

## Embioptera or Web-spinners of the New World

IN the *Proceedings of the United States National Museum*, 94 (1944), E. S. Ross gives an admirable review of the systematics of the Recent and Tertiary species of the insect order Embioptera of North and South America. Some 71 American species are recognized and these are distributed in 17 genera and 6 families. All the genera excepting Oligotoma seem to be endemic to the New World. The systematics of the order are almost entirely based upon the characters of the males. The females are neoteinic to a great extent and show but few characteristics. So far no features have been discovered to enable the genus or even the family of the females or of immature specimens to be identified. The best, or almost the only means, is to identify these by their definite association with known males. It is interesting to note that in the New World there are in the Clothodidæ species showing the most generalized structural features of the order, and in the genera Oligembia and Chelicerca those showing some of the highest specialization. The memoir, which extends to more than one hundred pages, includes 156 very clear text-figures illustrating structural details of the various species together with one photographic plate of wing venation. A work of this kind greatly aids in the identification of the insects concerned, and it is hoped that it will stimulate field collectors and students to devote attention to this peculiar but neglected order of insects.

## Witches' Broom of the Cacao

AN interesting study of the ecology of a parasitic fungus is described by R. E. D. Baker and S. H. Crowdy (Memoir No. 8, Dept. of Mycology and Bacteriology, Imp. Coll. Trop. Agric. Trinidad, Jan.

1944). The paper deals with field studies and control methods of the witches' broom disease of cacao, caused by *Marasmius perniciosus*. The malady has assumed serious proportions of recent years, and several types of broom have been described in earlier publications. Broom formation is maximal in January or February, and minimal in June or July. Cacao trees bloom all the year round, and cushion brooms are strongly and positively correlated with the numbers of flowers at any one time. The disease appears to be more closely associated with flowering than with vegetative growth. Shoot growth flushes five or six times a year, and fan brooms appear with the flush, though the total amount of shoot growth has little effect upon the numbers of brooms. It can apparently affect pods only at an early stage of development. Eradication of the fungus by direct methods does not appear to be feasible, and the search for immune or highly resistant varieties of cacao seems to provide the only practicable possibility of control.

### Development of the Eye in Drosophila

A. G. STEINBERG (*Proc. U.S. Nat. Acad. Sci.*, **30**, 5; 1943) has shown that the character 'bar eye' in Drosophila is controlled by the reduced size of the eye disk in embryo and by the fate of labile cells in the larval stage. These cells may either take part in eye formation or be transformed into chitin, according to the influence of external or internal causes. For mutants such as the 'lobes' and 'eyeless' in *D. melanogaster*, it would be interesting to know whether they developed in a similar way. Steinberg provides evidence that this is the case.

### Electrical Resistance Strain Gauges

A PAPER read recently in London by S. F. Dorey before the Institution of Mechanical Engineers deals with the measurement of static strains using electrical resistance strain gauges in conjunction with a Wheatstone bridge, and having a cathode ray oscillograph instead of the usual galvanometer. The advantages of this arrangement are indicated in the paper, and it is shown that stresses so low as 250 lb./sq. in. can be measured readily under workshop conditions, provided the correct technique is applied. Methods of calibration of this equipment and also its use in two specific problems are described.

### Bonding and Earthing of Single-Core Cables

AN article by E. A. Beavis and C. W. Schofield (*Eng. Supp. Siemens Magazine*, No. 216, April/May 1944) discusses the provisions which should be made for the bonding and earthing of metal-sheathed single-core paper-insulated lead-covered cables in three-phase installations. The subject is considered from the points of view of the sheath voltages which arise when the cables are bonded and earthed at one point only, and of the circulating currents which flow along the sheaths when multiple bonding and earthing is employed. The type of installation to secure minimum transmission losses, characteristics of various types of installations, earthing and bonding for various types of installations, and theoretical considerations of induced voltage and sheath current are discussed and, finally, the authors give some practical test results. The investigation covers cables for voltages of from 1 kV. to 33 kV., of cross-sectional areas of 0·25–1·5 in.$^2$ according to voltage, and at cable spacings ranging from 2 in. to 120 in. Provided sheath voltages are not allowed to reach dangerous values, especially under fault conditions, it is concluded that earthing and bonding at one point is the ideal arrangement.

### Flow of Current between Electrodes on a Metal Surface

A PAPER by the late Prof. W. M. Thornton describes investigations carried out on this subject (*J. Inst. Elec. Eng.*, **91**, Pt. 2, No. 20; April 1944). Measurements of the thickness of metal plates or tubes from one side only can now be made by a direct-current electrical method. In the 'four points in line' method a low voltage is applied by point contacts to the surface and the potential drop between them observed. In B. M. Thornton's 'six points in line' method there are two pairs of points on which the potential is observed, and in Warren's 'eight point' method the electrodes are arranged in two squares. On account of the spread of the current, the readings on the potential points differ and their ratio is an indication of the thickness of the plate. The six- and eight-point methods give values for the thickness that are independent of the resistivity of the metal. The theory of the flow of current between two electrodes in an infinite plate is well known; but the surfaces to be examined for thickness are in practice restricted in area and have boundaries which are not always of regular shape. The influence of proximity of the electrodes to a free edge has been previously examined. The paper deals with the flow of current between point electrodes in circular and elliptical areas, a square, a rhombus, narrow and wide lenticular areas and a narrow lune. The flow between points on the surface of metal tubes is considered. Results obtained by the 'six points in line' method are quoted and a collection of derived formulæ is added.

### Flow of Fluid through a Nozzle

THE equations of motion of a compressible fluid, such as steam, through a nozzle present great difficulty even when the fluid is assumed to have no viscosity. Osborne Reynolds's well-known treatment (1886) applied only to the one-dimensional case when the velocity was uniformly distributed over each cross-section. In two dimensions very few exact solutions are known, and these relate to cases which are not realizable in practice. Rayleigh (1916) proposed a method of successive approximations. Taylor and Sharman (1928) used an electrical analogue to obtain solutions by experiment; their method failed when the speed exceeded the local speed of sound. A recent paper by J. R. Green and R. V. Southwell (*Phil. Trans. Roy. Soc.*, A, **239**, 367; 1944) gives an approximate numerical method based on Southwell's general method of 'relaxation', which he has applied to a whole series of engineering problems. Given the shape of the nozzle, the first step is to use a conformal transformation of this shape into a rectangle. The exact differential equations are replaced by approximate equations of finite differences, which are easier to solve. Then, in accordance with the relaxation technique, the error of these approximations is expressed in terms of 'residual forces', and finally these 'forces' are 'liquidated', that is, reduced to negligible magnitudes. Like the electrical method, the relaxation method fails when the speed exceeds that of sound. An alternative method, not yet fully worked out, is proposed to deal with this case.

# AMINO-ACID MIXTURES AS AN ADDITIONAL FOOD FOR PREMATURE INFANTS

By J. HENNING MAGNUSSON
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IT is generally agreed that human milk is far superior to all other foods for premature infants, and this form of nutriment seems to be one of the essentials for a low mortality. As a rule, however, these infants have begun their extra-uterine life far too early, and in their case, therefore, breast milk cannot be said to be the ideal nourishment to the same extent as it is for those born at term. In the rearing of premature infants, also, there is the question of supplying food in sufficient quantities to be met, a factor which need not be considered with full-term babies. This difficulty is especially noticeable in the case of small infants whose weight at birth is considerably below 2,000 gm. To cover the high calory requirements of these infants solely by means of human milk, with its 70 or so calories per decilitre, places a high demand not only on the holding capacity of the stomach but also on the digestive organs as a whole. It should be remembered, also, that in nearly all premature infants the digestive organs are functioning below par, during the first weeks at least.

Because of the tendency of these infants to develop acute inanition, a regular feeding regimen must be started early; but only small amounts of breast milk can be given during the first days. The amounts supplied must be kept strictly within the limits of the minimal food requirements for life, and overfeeding must be as conscientiously avoided as underfeeding. Increases in food are made only very gradually, and the smaller and the more premature the infant the greater the care which must be exercised. Further increases in amount are based on the weight of the infant and on the infant's food tolerance.

When the premature infant is fed on human milk, the weight curve, after the initial drop, not infrequently remains almost horizontal for the first three, or even four weeks of life. After that, it begins gradually to rise, so long as no complications, in the form of intercurrent infections, arise.

Various supplementary foods have been tried with the view of increasing the calories the infant receives through the breast milk. In the majority of cases these have consisted of small feeds of a concentrated cow's milk mixture, the main purpose with these being to meet the large requirements of mineral salts and protein. Other observers have tried additional feeds of casein or glucose, or a mixture of both of these.

The premature infant requires a diet which is readily assimilable and rich in proteins. An amino-acid mixture ought to be capable of fulfilling these conditions, especially in view of the fact that amino-acids of low molecular weight are absorbed as easily as sugar while whole protein molecules are not absorbable. There is also reason for believing that infants at this early stage of development have an imperfectly functioning enzymic mechanism, and that, because of this, they cannot properly assimilate the ordinary foods. If this is really the case, then the unsatisfactory gain in weight so often observed during the first weeks of life must be nothing more or less than a sign of starvation.

Since November 1943, I have been experimenting with amino-acid mixtures as a supplement to human milk. More than thirty infants have been treated, and uniformly good results have been obtained. In the pediatric literature which has found its way to Sweden under the present war-time restrictions, I have only succeeded in finding two reports on the use of amino-acids as an additional food for young infants[1,2]. The feeding of amino-acid to prematurely born infants, on the other hand, does not seem to have been tried.

The amino-acid mixture used is 'Aminosol', manufactured by Vitrum, of Stockholm, a preparation worked up by Drs. E. Jorpes and K. A. J. Wretlind, of the Department of Chemistry, Karolinska Institutet. It is prepared by enzymic disintegration of casein followed by dialysis of the amino-acids, and it contains 80–85 per cent free amino-acid. As the yield of the starting material is 80–100 per cent in this preparation, the amino-acid content can be said to be the same as in casein. Glucose was added to the amino-acid mixture in order to supply calories. To meet the salt requirements, Osborne-Mendel salt mixture was also added. Thus the preparation used in my experiments ('Aminosol'-glucose) had the following composition: amino-acid mixture 25 per cent, glucose 25 per cent, and salt mixture 1·5 per cent.

In most instances the mixture was given through a catheter concurrently with the breast milk during the first days, or weeks, of life, and later by the oral route. The question of dosage has not yet been definitely established. As a rule, the daily dose given

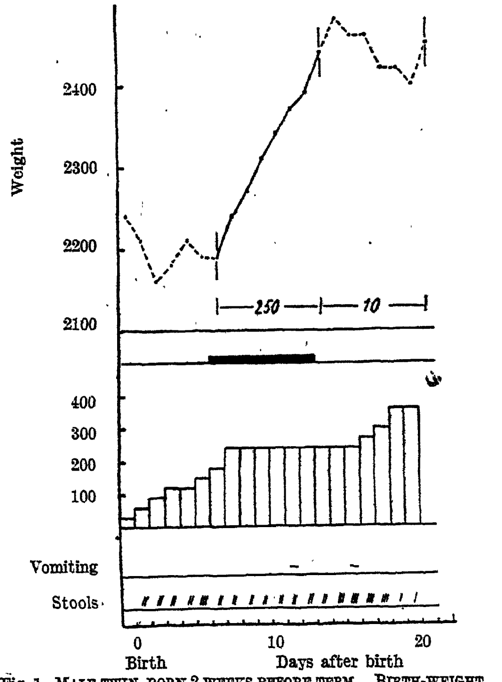


Fig. 1. MALE TWIN, BORN 2 WEEKS BEFORE TERM. BIRTH-WEIGHT, 2,160 GM.

In the weight curve, - - . - - - . - - - . indicates periods during which the infant received breast milk only, and . — . — . periods in which it was supplemented by 'Aminosol'-glucose. The figures between the vertical lines below the weight curves show the weekly gain in weight, and equals 'Aminosol'-glucose (10 c.c. daily per kgm.) as additional food.

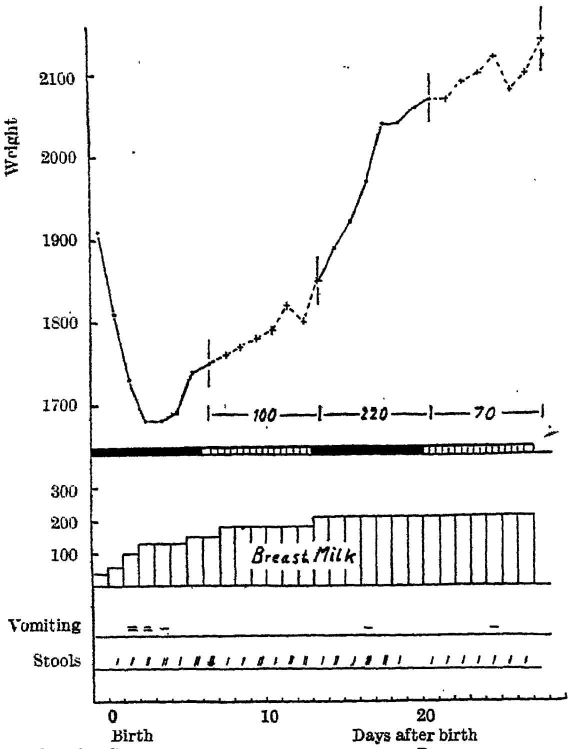


FIG. 2. GIRL, BORN 1 MONTH BEFORE TERM. BIRTH-WEIGHT, 1,960 GM.

In the weight curve, + - - + - - indicates periods in which the infant received, in addition to the breast milk, undigested casein plus glucose plus salt mixture, and the 'ladder' below indicates the amount of this mixture (10 c.c. daily per gm. body weight) which was fed.

was 10 c.c. of 'Aminosol'-glucose per kgm. of body weight. This amount was almost invariably well tolerated by even the smallest of the infants without any complications arising in the form of vomiting or digestive disturbances. With some infants half this dose was sufficient to produce a good gain in weight. The cases cited below are appended to illustrate the results.

Some data are presented in Fig. 1.

It cannot be asserted with certainty that the greater gain in weight occurring while the infant was receiving the additional feeds of 'Aminosol'-glucose was due exclusively to the amino-acid mixture, although from the physiological point of view it would seem obvious that this was the cause. One objection that may be raised against this assumption is that the infant was receiving more calories during these periods and that the gain in weight was due to this fact. In order to clear up this point, a series of tests was made in which the effect of feedings of 'Aminosol'-glucose was compared with the result obtained from a mixture containing undigested casein, glucose, and mineral salts of the same strengths and in the same proportions as in 'Aminosol'-glucose. The only difference in the two foods was that the amino-acid mixture was exchanged for undigested casein. Some results are shown in Fig. 2.

In all the tests in which the effect of the amino-acid mixture was compared with that of undigested casein, the gain in weight was much greater in the periods during which the amino-acid mixture was being fed. Thus the amount of calories we supplied through this additional food cannot in itself have been the reason why the infant put on so much extra weight. The cause is undoubtedly to be sought in the feeding of amino-acids. To judge from certain cases, it would almost seem as if the amino-acids are used quantitatively for protein synthesis, since the daily weight increase was approximately equal to the gain in weight which would be obtained through protein synthesis and binding of the corresponding amount of water.

[1] Shohl, A. T., Butler, A. M., Blackfan, K. D., and MacLachlan, E., *J. Pediat.*, **15**, 469 (1939).

[2] Hill, L. W., *J. Amer. Med. Assoc.*, **116**, 2135 (1941).

# TEACHING OF PLANT GENETICS

ON February 20, 1943, Dr. W. Burns, agricultural commissioner with the Government of India, delivered his presidential address to the Indian Society of Genetics and Plant Breeding on the subject of the teaching of plant genetics in India (*Indian J. Genetics and Plant Breeding*, **3**, 1; 1943). His comprehensive survey and discussion of this question, based as they are on a wide experience of the application of genetics to Indian agriculture, call for consideration in some detail.

Dr. Burns thinks that the rudiments of genetics should form part of the liberal education of those who proceed beyond the secondary school, because our behaviour and reaction to many situations must be profoundly affected by our understanding of the part played by heredity. A general raising of the level of biological teaching in schools is one of the essential prerequisites of teaching genetics and would enable "the future citizen, administrator or specialist to handle problems dealing with living things, including man, less ignorantly". The specialist in biology, medicine or agriculture requires, of course, a wider knowledge of genetics, since there are few biological problems the genetical aspects of which can be safely neglected. The plant breeder must have available to him all the resources of genetical science.

Genetical teaching is bound to be affected by the rapid and, in some ways, uneven growth of the subject. The necessary perspective could be introduced by a short historical survey. Elementary courses in genetics should aim at making clear the basic concept of the genotype and the chromosome theory of heredity, and should be preceded by a botany course and an introduction to biometrical mathematics. Instruction in cytology should be included in the botany course, and should involve the making of simple preparations of dividing nuclei. Practical work in elementary genetics itself would of necessity be largely on prepared material in the laboratory.

The biological specialist requires an additional preliminary course in floral biology to acquaint him with the structure and action of different floral mechanisms, the operation of incompatibility, and the methods used in making controlled pollination by artificial means. The genetical course itself should begin with a biometrical study of naturally occurring variation, proceeding via the distinction between heritable and non-heritable variation to Mendelism and chromosome theory. The student should count

segregating families and so be led to an understanding of sampling variation and tests of goodness of fit. Finally, the bearings of genetics on evolutionary theory and taxonomy should be made clear, with special reference to complex, or polygenic, inheritance. This would require that the teachers themselves should have studied the problem carefully, and should have "some form of belief and not merely a chaos" in their minds. Dr. Burns also recorded a protest against the tyranny of the herbarium method and a plea for a fuller study of living plants in taxonomy.

With reference to the plant breeder, it is clear that he should receive a fuller mathematical training than the other classes of student, for otherwise he must acquire it "painfully, perhaps self-taught" at a later and less convenient stage. He should also have a more comprehensive course in genetics, though it could be modelled on the lines sketched earlier. He would require an introduction to the modern theory and practice of field experiments, with practical work involving responsibility for an actual trial. The part to be played by statistics was discussed in relation to the danger of an undue adherence to statistical methods leading to a neglect of the living plants. The solution is essentially that of training the breeder to rely primarily on observations of, and familiarity with, his crop; and to show him how his observations can be amplified and checked by statistical analyses.

Dr. Burns concluded with a survey of the present position of genetics teaching in India, which he found far from satisfactory. He advocated the giving of preliminary instruction in the universities and of advanced courses in agricultural institutes. Above all, if this genetical teaching is to be fruitful the students must be led to grow plants and study them as living things. The provision of facilities for this should not be too great a tax on the resources of educational establishments; but there is a need for a small hand-book of practical genetics using the plants, chillies, rice, etc., with which Indians are familiar.

This discussion of teaching in plant genetics is noteworthy in a variety of ways, but especially perhaps for its insistence on the following points:

(1) The argument for the wider teaching and appreciation of general biology and the genetical point of view.

(2) The introduction of perspective into genetics by the approach through observable variation in Nature and the linking of genetics to evolutionary theory and taxonomy.

(3) The need for preliminary courses in floral biology and mathematics, and the introduction of modern statistical methods into the teaching.

(4) The emphasis on relating genetics teaching to the living organism as a corrective to over-formalization.

It must be remembered that Dr. Burns was discussing plant genetics in India, and so his various points may not apply with equal emphasis to all genetics in all countries. His separation of cytology from genetics and its inclusion in the botany course, for example, will not be desirable everywhere. Nevertheless, his conclusions and proposals merit the careful study of all who are concerned with genetics and its teaching. His remarks are indeed especially timely in view of the expansion of genetics and genetical teaching which must now be contemplated in Great Britain.

# GEOLOGISTS IN THE POST-WAR PERIOD

THE total number of British geologists wholly engaged in a professional capacity in pre-war years was probably less than six hundred, nearly one quarter of whom were occupied in the teaching of the science, principally in the universities. To some extent this high proportion of geologists engaged in academic spheres is due to the fact that large classes of technical students in mining, metallurgy, civil engineering, and agriculture require tuition in geology as a part of their professional training.

The Geological Society of London has recently given evidence on the post-war recruitment of professional geologists, to the Inter-Departmental Committee on Further Education and Training, under the chairmanship of Lord Hankey. After expressing the hope that geology should be introduced into the schools as a fundamental study in general science courses, the Society stressed the important part that geologists play in the discovery and development of mining fields and oilfields, and in many branches of civil engineering.

In spite of the importance of geological work, the normal pre-war number of fully-trained geologists graduating each year from British universities is only about thirty. Although there have been wide fluctuations in the demand for mining and oil geologists, as a result of trade cycles, the supply of suitable men has usually been inadequate. It is probable that there will be a still greater dearth of British-trained geologists in the immediate post-war period, owing to the requirements of industry, Government Geological Surveys, and university teaching staffs. Within two years after the cessation of hostilities, it seems likely that considerably more than a hundred recruits will be called for to fill gaps and augment the ranks of professional geologists. It is certain that as soon as the War ends, there will be a demand for more men on the Geological Survey of Great Britain and the Colonial Geological Surveys.

Owing to impending retirements and proposed expansion of staff, there will be an immediate call for not less than ten men on the Geological Survey of Great Britain, with further recruitment in succeeding years. Representations have been made to the Secretary of State for the Colonies by the Geological Society and the Institution of Mining and Metallurgy, and it is confidently anticipated that many additional geologists will be enrolled for the staffs of the Colonial Geological Surveys. Not only is there a need for pressing on with routine geological mapping in the Colonies, but there is also great scope for more work to be done in connexion with the development of mineral resources, water supply, public works (dams, reservoirs, harbours, roads, etc.), and soil conservation. It has also been pointed out that several heads of university geological departments must soon be retiring under the age limit, and a number of junior posts in these departments will also be vacant. Within recent years new avenues of employment for geologists in industry have been opening up.

There are ample opportunities for trained geologists in the British oil companies, which face immediate post-war projects necessitating the employment of geological staffs larger than heretofore. Oilfields in Burma and elsewhere in the Far East will have to be re-opened, and studies must be made of the effect of Japanese operations, and of the best means of re-

suscitating the oilfields. To offset damage to operating fields, exploration to discover new ones must be accelerated. British interests, whether co-operating or competing with those of the United States, must enlarge their fields of action, and they will need to engage large staffs of oil geologists to do this effectively. Moreover, geologists in oil companies are continually being attracted out of the exploratory phase into production and field management.

In addition, after the War there is likely to be a widespread development of young mining fields and a general exploration for new metallic and non-metallic mineral deposits, which will involve the services of many mining geologists. Such men must also be recruited into the Government Geological Surveys in greater numbers than has hitherto been the practice.

## GRAVITATION, ELECTROMAGNETISM, AND QUANTUM THEORY

A RECENT paper by Einstein and Bargmann[1] declared that "Ever since the theory of general relativity has been developed there has existed the problem of finding a unified theory of the physical field by some generalization of the relativistic theory of gravitation . . . a decisive modification of the fundamental concepts is unavoidable". Schrödinger[2] has also explained the need for a generalization of Einstein's original postulates in order to unify the theories of gravitation, electromagnetism, and the mesonic field responsible for binding the nucleus. There is no danger of the work of Einstein and Schrödinger being overlooked, but there is great danger that what is apparently an investigation of great importance, namely, "The Theory of Indeterminate Space-Time", by F. R. Saxby, may be missed by physicists, as it appears not in any of the usual scientific journals, but in the *Bulletin of the Research Laboratories of the National Cash Register Company* (pp. 13–72, September 1943), of which laboratories he is mathematics staff engineer.

Mr. Saxby proceeds on something like the general lines of the recent work of Einstein and Schrödinger, being influenced, like them, by the variations introduced into the original relativity theory by Weyl and Eddington; but his treatment has one strikingly original feature, which seems to link up quantum theory with relativity. If this claim can be substantiated, a great advance has been made. As Schrödinger[2] remarked: "At the back of our striving for a unitary field theory, the great problem awaits us of bringing it into line with quantum theory. This point is still covered with deep mist."

It is difficult to give a summary of Saxby's paper without complicated mathematics, but at any rate it can be indicated how it is related to Schrödinger's investigations. Both agree that the first step is to assume, as a postulate, that a certain correspondence exists between two vectors at two neighbouring points of space, or more generally between two *tensors* at two neighbouring points of space-time. The relation assumed is of a special form, known technically as an 'affine connexion'. It contains sixty-four arbitrary coefficients. In Einstein's original theory there were certain additional assumptions which restricted these coefficients, in particular an assumption of symmetry. Both Schrödinger and Saxby emphasize the non-symmetric case, the former to account for the meson field, the latter to account for the quantum. In both cases the gravitational part of the theory is much the same as in Einstein's older theory, but there are novelties in the electromagnetic part, particularly in Saxby's treatment, which differs radically from any previously given. It is claimed that the new theory links up the indeterminism of the electromagnetic potentials with Heisenberg's principle of uncertainty.

Mr. Saxby admits that much has yet to be done in developing his theory, and it is to be hoped that he will be able to publish an account of it in periodicals usually taken by university libraries. Einstein's own new investigations[1] go more deeply into the purely mathematical side of the correspondence between two tensors, but he says: "whether we have succeeded in approaching the solution of this physical problem [that is, that of a unified theory of physics] is still uncertain. The answer to this question depends, among other things, on a mathematical problem which we have not yet been able to solve".

H. T. H. PIAGGIO.

[1] Einstein, A., and Bargmann, V., *Ann. Math.*, **45**, 1 (1944).
[2] Schrödinger, E., *Nature*, **153**, 572 (1944).

## IMPERIAL FORESTRY INSTITUTE, OXFORD

THE nineteenth annual report of the Imperial Forestry Institute, Oxford, for 1942–43 is inevitably coloured by war conditions. It proves somewhat difficult for those interested but not connected with Oxford to distinguish the actual staff of the Department or School of Forestry from that of the Imperial Forestry Institute; in other words, the part of the forestry staff maintained by the University of Oxford from its own funds as compared with the grants expended upon the Institute coming from Government sources, Forestry Commission, several Colonies, and so forth.

As the report remarks, the Forestry Commission has issued a White Paper (Cmd. 6447) on future forest policy in Great Britain, which has not yet received the sanction of the House of Commons. A Supplementary Report (Cmd. 6500. London: H.M. Stationery Office, 2*d.* net), dealing with the forest policy of private woodlands, was published early in 1944. There had been controversy on the proposals in the first White Paper for the treatment of the private landowner and his woodlands (which had provided the bulk of the timber and other forest materials required for the War) and considerable opposition became apparent throughout the country. A conference was held between the Forestry Commission and representatives of landowners and forestry societies, and the reconsidered proposals agreed upon, mainly connected with the help which could be granted to private landowners towards afforesting and re-afforesting their felled-over lands, were published in the Supplementary White Paper.

The portions of the White Paper alluded to in the Imperial Forestry Institute's report are the sections on education and research, which particularly concern the Institute. It appears that during the year the Committee for Forestry at Oxford considered a report on the future policy of the Institute drawn up by a sub-committee. The report was adopted with certain modifications, "but it was considered necessary to keep it pending the expected publication

of the views and proposals of H.M. Forestry Commission on Post-War Forestry Policy in this Country". It is difficult to appreciate the reason for the above statement.

The Imperial Forestry Institute is an Empire organization, or at its inauguration was intended as such. Practically the whole of the forest wealth of the Empire is outside the British Isles and must remain so for many years to come. Research work is presumably one of the important branches of the Institute, and it would appear reasonable that closer co-operation in such work would be at least as necessary as with the Forestry Commission, which is so stressed in the report. Moreover, there are other universities with forest departments ready to undertake research work in collaboration with the Forestry Commission; but there is only one Imperial Forestry Institute, and that is situated at Oxford.

The suggestion for raising the status of the Institute from a pass to an honours school is a wise and far-sighted move.

The only students under instruction during the year were the Colonial forestry scholars, four attending the Institute, two of whom were forestry graduates. There was also one candidate for B.Sc., and one for D.Phil. working under the supervision of the professor of forestry.

# A NEW MEXICAN VOLCANO

P. D. TRASK has recently given a preliminary account of the inception and growth of a new volcano, El Paricutin, situated about two hundred miles due west of Mexico City (*Trans. New York Acad. Sci.*; Dec. 1943).

Prof. L. C. Graton, professor of mining geology at Harvard, spent nearly two months in the region making trips to it and flying over it twice; and he describes its growth in *Sky and Telescope* of February. A well-illustrated article on the volcano also appears in the *National Geographic Magazine* of February 1944.

The first intimation of awakening activity was the occurrence in February 1943 of numerous earthquakes in the district. On February 19 some three hundred shocks were reported. The next day a Tarascan Indian farmer was astonished to see 'smoke' spiralling up from a hole in a field which he was ploughing.

That night the first explosion occurred, and since then—at least up to the end of the year—the volcano has been erupting steadily. Within a week the cone reached a height of 550 ft. and by late September it had grown to 1,500 ft. During the early days explosions in quick succession expelled a cylindrical column of ash which, after reaching a height of some hundreds of feet, suddenly formed dark expanding clouds that billowed up to 6,000 – 8,000 ft., when steam began to condense, after which the ash cloud became progressively whiter until it passed into a horizontal cloud of curling puffs of vapour at about 15,000 – 18,000 ft. Later on, much of the fragmental material consisted of red-hot bombs, blown 2,000 – 3,000 ft. into the air. A cone 100 ft. high was built up in the course of the first day.

Two days after the birth of the volcano, lava emerged from a field about a quarter of a mile from the crater and continued to flow for six weeks, by which time it was more than a mile long and 100 ft. thick. Early in June eight lava flows issued from the cone itself. The crater at this time was occupied by lava to within 50 ft. of the rim, and through the congealed blocky surface ashes were being erupted. It was observed that each flow was preceded by a phase of violent explosive activity, but that while lava was actually escaping, explosions were relatively few. By September several other flows had broken through the flanks of the cone. The lava consists of andesitic basalt of essentially the same type as that erupted by the hundreds of older and now apparently extinct volcanoes that occur within a radius of about seventy-five miles around Parícutin.

It is of interest that the only previous volcanic activity in the region, within the memory of man, occurred in 1759 when the celebrated new volcano of Jorullo suddenly appeared, some fifty miles to the south-east of Parícutin, and built a 1,000-ft. cone in five months of activity.

# NATIVE RESERVES IN SOUTH AFRICA

THE Native Reserves provide homes for one third of the South African population, and constitute the chief source of labour for mines and industries. Soil wastage, resulting from over-stocking and primitive methods of agriculture, is rapidly converting the reserves into deserts. A memorandum, drawn up at the suggestion of the Cape Town Branch of the Association of Scientific Workers of Southern Africa, puts forward a comprehensive scheme of reorganization*.

A start might be made in the following terms with certain limited areas, and the new system gradually extended until it covers the entire Reserves. (1) An ecological survey of the given area; (2) the area to be fenced and made into suitable paddocks for summer and winter grazing; (3) all scrub bulls to be culled and the necessary number of good bulls to be provided; (4) progressive limitation of cattle to the estimated carrying capacity of the land. It would be a good thing to regard each area as a collective farm, and each communal farm should have a communal centre with offices, hall for meetings and lectures, perhaps a school building, barns and silos, sheds for storage, etc. An African agricultural officer, as general adviser, should be stationed at each farm. Families would be entitled to their own plots of arable land fenced off from the communal land. Though encouraged to store and market collectively, the individual peasant would be entitled to the products of his own land, and individual ownership of cattle would have to be tolerated. All able-bodied members of the *commune* would be expected to provide a minimum amount of labour under the management of a committee. Technical training schemes would also be desirable.

It is realized that certain major changes in South African governmental policy—improvement in the social and commercial conditions of Africans outside the Reserves and provision of more land and industrial opportunities within—must accompany any serious attempt to deal with the general problem.

K. L. LITTLE.

* Association of Scientific Workers of Southern Africa. Research Memorandum, No. 3. The Native Reserves and Post-War Reconstruction. By Edward R. Roux. (Cape Town.) 6*d*.

## FORTHCOMING EVENTS

### Wednesday, July 19

IRON AND STEEL INSTITUTE (joint meeting with the SHEFFIELD BRANCH OF THE INSTITUTE OF BRITISH FOUNDRYMEN) (at the Royal Victoria Station Hotel, Sheffield), at 7 p.m.—Mr. P. C. Fassotte: "Developments in the Design and Use of Side-Blown Converter Plants".

### Thursday, July 20

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 3 p.m.—Mr. G. A. Barnard: "Some Applications of Modern Higher Algebra to Engineering Statistics".

### Friday, July 21

GENETICAL SOCIETY (in the Department of Comparative Anatomy, University Museum, Parks Road, Oxford), at 12 noon—Annual Meeting.

## APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DEMONSTRATOR (man or woman) IN THE DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (July 17).

LECTURER IN MATHEMATICS AND PHYSICS—The Director, Robert Gordon's Technical College, Aberdeen (July 18).

TEACHER (full-time) OF MATHEMATICS, SCIENCE and DRAWING, mainly for employment in a new Junior School of Building—The Secretary, Bridgwater Art and Technical Institute, 142 Chilton Road, Bridgwater, Somerset (July 19).

EDUCATIONAL PSYCHOLOGIST (full-time) to work in the Child Guidance Clinic and in connexion with Schools and Institutions—The Director of Education, Education Offices, Deansgate, Manchester 3 (July 20).

SCIENCE MASTER or MISTRESS for the Boys' Junior Technical and Day Continuation School—The Organizer of Further Education in Rugby, College of Technology and Arts, Eastlands, Rugby (July 21).

ASSISTANT MASTER (Graduate preferred) to teach MATHEMATICS and SCIENCE, particularly CHEMISTRY—The Headmaster, Eastbourne Junior Technical School and Evening Institute, The Grange, St. Anne's Road, Eastbourne (July 22).

SUPERINTENDENT OF THE ENGINEERING DIVISION of the National Physical Laboratory—The Director, National Physical Laboratory, Teddington, Middx. (July 22).

LECTURESHIP IN CHEMISTRY—The Registrar, The University, Reading (July 24).

LECTURER IN MECHANICAL ENGINEERING—The Registrar, King's College, Newcastle-upon-Tyne (July 24).

LECTURER FOR MECHANICAL OR AERONAUTICAL ENGINEERING SUBJECTS—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1 (July 24).

LECTURER (full-time) IN PHYSICS AND MATHEMATICS in the Engineering Department of the Schools of Technology, Art and Commerce—The Chief Education Officer, City Education Office, 77 George Street, Oxford (July 24).

CHEMISTS (temporary) with considerable experience in analysis of metals—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2828A) (July 25).

CHAIR OF MATHEMATICS tenable at the Royal Holloway College—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (July 26).

LECTURER IN EXPERIMENTAL PHYSIOLOGY—The Registrar, The University, Sheffield (July 28).

SUPERINTENDENT OF THE LIVERPOOL GAS COMPANY'S CENTRALIZED CONSTRUCTION AND WORKS MAINTENANCE DEPARTMENT—The Personnel Superintendent, 18–26 Bold Street, Liverpool 1 (July 29).

ASSISTANT SECRETARY to the Oxford and Cambridge Schools Examination Board—The Chairman of the Oxford Delegacy, St. Catherine's Building, St. Aldate's, Oxford (July 31).

ASSISTANT LECTURER IN THE DEPARTMENT OF MATHEMATICS, an ASSISTANT LECTURER (temporary) IN THE DEPARTMENT OF PHYSICS, and an ASSISTANT LECTURER (temporary) IN THE DEPARTMENT OF ENGINEERING (with special qualifications in Electrical Engineering)—The Registrar, University College, Singleton Park, Swansea (August 5).

SENIOR TECHNICAL OFFICER (temporary) at London Headquarters of the Ministry of Town and Country Planning—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. EA. 950A) (August 10).

READERSHIP IN PHYSICAL ANTHROPOLOGY—The Registrar, University Registry, Oxford (August 31).

CHAIR OF ELECTRICAL ENGINEERING—The Acting Registrar, The University, Leeds 2 (September 30).

SECRETARY—The Hon. Secretary, Illuminating Engineering Society, 32 Victoria Street, London, S.W.1.

LECTURER (full-time) IN THE SCIENCE DEPARTMENT (principal subjects: Inorganic, Organic and Physical Chemistry, with subsidiary Physics)—The Registrar, Merchant Venturers' Technical College, Bristol.

PSYCHIATRIC SOCIAL SERVICE WORKER for the Glasgow Royal Mental Hospital and associated Out-patient Clinics—The Medical Superintendent, Glasgow Royal Mental Hospital, 1055 Great Western Road, Glasgow.

GRADUATE TEACHER OF GENERAL SCIENCE OR GENERAL ENGINEERING SUBJECTS in the Burton-on-Trent Technical Institute and Junior Technical School—The Secretary and Director of Education, Education Offices, Guild Street, Burton-on-Trent.

SENIOR MASTER with good Honours Degree in Science or Mathematics, and an ASSISTANT MASTER with Degree in Science or Mathematics, in the Leeds Central High School—The Director of Education, Education Offices, Leeds 1.

ASSISTANT MASTER qualified to teach ENGINEERING SUBJECTS and MATHEMATICS up to Ordinary National Certificate standard—The Principal, Technical Institute, Beckenham Road, Beckenham, Kent.

TEACHER OF MATHEMATICS, PHYSICS AND CHEMISTRY, and a TEACHER OF MECHANICAL ENGINEERING, ELECTRICAL ENGINEERING and BUILDING—The Principal, Technical College, Bradford Place, Walsall.

LABORATORY ASSISTANT IN THE DEPARTMENT OF PHYSICS—The Bursar and Acting Registrar, University College of North Wales, Bangor.

## REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

Proceedings of the Royal Irish Academy. Vol. 49, Section A, No. 1
The Point Charge in the Unitary Field Theory. By Erwin Schröding
Pp. 225–236. 1*s*. Vol. 49, Section A, No. 13: Unitary Field Theo
Conservation Identities and Relation to Weyl and Eddington. B
Erwin Schrödinger. Pp. 237–244. 1*s*. Vol. 49, Section A, No. 14:
On the Cascade Production of Mesons. By H. W. Peng. Pp. 245–258.
1*s*. 6*d*. Vol. 49, Section A, No. 15: The Shielding Effect of Planetary
Magnetic Fields. By James McConnell and Erwin Schrödinger.
Pp. 259–274. 1*s*. Vol. 49, Section A, No. 16: The Union of the Three
Fundamental Fields (Gravitation, Meson, Electromagnetism). By
Erwin Schrödinger. Pp. 275–288. 1*s*. 6*d*. Vol. 49, Section A, No. 17:
The Paths of the Particles in a Vortex Street. By W. B. Morton
Pp. 289–292. n.p. Vol. 49, Section B, No. 14: Note on the Physiology
of the Mammalian Epididymis and Spermatozoon. By Lawrence
Collery. Pp. 213–224. 1*s*. Vol. 49, Section B, No. 15: Molecular
Rearrangements of Phenyl Styryl Ketone Oxides. By Joseph Algar
and James McKenna. Pp. 225–250. 1*s*. (Dublin: Hodges, Figgis
and Co., Ltd.; London: Williams and Norgate, Ltd.). [136

Science and Industry. Reports of the Meetings arranged by the Manchester Chamber of Commerce in collaboration with the Department of Scientific and Industrial Research. Pp. 63. (Manchester: Manchester Chamber of Commerce.) 1*s*. 6*d*. [146

Imperial Agricultural Bureaux. Joint Publication No. 6: Alternate Husbandry. Pp. 158. (Aberystwyth: Imperial Agricultural Bureaux.) 5*s*. [146

Scientific Proceedings of the Royal Dublin Society. Vol. 23 (N.S.), No. 22: The Gametophytes of *Podocarpus andinus*. By W. J. Looby and J. Doyle. Pp. 222–237+plates 6–9. 3*s*. 6*d*. Vol. 23 (N.S.), No. 23: Report of the Radium Committee for the Year 1943. P. 238. n.p. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.). [156

The Morphology and Biology of *Culex molestus*: Observational Notes for Investigators. By John F. Marshall. Pp. iv+16. (Cheltenham: The Author, 47 London Road.) 1*s*. [266

The Control of Land Use. (Cmd. 6537.) Pp. 16. (London: H.M. Stationery Office.) 3*d*. net. [266

Institute of Welding. Twenty-first Annual Report of the Council; Accounts and Balance Sheet for 1943–44. Pp. 22. (London: Institute of Welding.) [266

University of London. Report of the Principal on the Work of the University during the Year 1943–44. Pp. 6. (London: University of London.) [266

### Other Countries

Carnegie Institution of Washington. Publication 552: The Mutants of *Drosophila melanogaster*. By Calvin B. Bridges. Completed and edited by Katherine S. Brehme. Pp. vii+257+3 plates. (Washington, D.C.: Carnegie Institution.) 2.50 dollars. [1

Uganda Protectorate. A Working Plan for Settlement Forests, Lango District, Uganda. By C. S. Cree. Pp. 24. (Entebbe: Government Printer.) [146

The Maine Bulletin. Vol. 46, No. 11 (University of Maine Studies, Second Series, No. 59): The Woody Plants of Maine; their Occurrence and Distribution. By Fay Hyland and Ferdinand H. Steinmetz. Pp. xix+72 (8 plates). (Orono, Maine: University of Maine.) 50 cents. [146

Memoirs of the American Philosophical Society. Vol. 21: Sumerian Mythology, a Study of Spiritual and Literary Achievement in the Third Millennium B.C. By S. N. Kramer. Pp. xiv+125+21 plates. (Philadelphia: American Philosophical Society.) [156

Fouad I University. Bulletin of the Faculty of Science, No. 17: Flora of Egypt. Vol. 1: Pteridophyta, Gymnospermæ and Angiospermæ, part Monocotyledones: Typhaceæ—Gramineæ. By Vivi and Gunnar Täckholm, in collaboration with Mohammed Drar. Pp. 574. (Cairo: Fouad I University.) [266

Société des Nations: League of Nations. Lexique polyglotte des maladies contagieuses: Contribution à la Nomenclature nosologique internationale. (Polyglot Glossary of Communicable Diseases: Contribution to the International Nomenclature of Diseases.) Par le Dr. Yves Biraud. (Reprinted from the *Bulletin of the Health Organisation*, Vol. 10, No. 3, 1943–44.) Pp. 201–556. (Geneva: League of Nations; London: George Allen and Unwin, Ltd.) 4*s*. [266

Twenty-sixth Annual Report of the National Research Council of Canada, 1942–43. (N.R.C. No. 1169.) Pp. 36. (Ottawa: National Research Council of Canada.) [276

Lord Rutherford. By Prof. T. H. Laby. Pp. 16. (Melbourne: Whitcombe and Tombs, Ltd.) [296

### Catalogue

Soya Flour: Make your Dishes more Nutritious. Pp. 4. (Elstree: Soya Foods, Ltd.)

# NATURE

No. 3899 SATURDAY, JULY 22, 1944 Vol. 154


CONTENTS




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## FUNCTIONAL APPROACH TO INTERNATIONAL CO-OPERATION

NO feature of the recent conference of Prime Ministers of the British Empire has been of wider interest than the attention given to the shaping of international organization after the War. No less impressive than the evidence of the unity of the British Commonwealth on essentials, and of its identity of spirit and resolve, is that of willingness to assume the responsibilities of world leadership and to make constructive proposals for the organization and maintenance of world peace. The emphasis placed on the inclusive rather than exclusive character of the British Empire is welcome and wise, all the more when, as in the recent speeches of Mr. Cordell Hull, of Mr. Dewey and others, there is evidence that the United States is giving equal attention to such questions. Furthermore, it is clear that some American periodicals such as *Foreign Affairs* are making a bold attempt to prepare American opinion to face whatever changes may be involved and to clear away misunderstandings that might hinder Anglo-American co-operation.

An interesting feature of recent discussions has been the tendency to reconsider the verdict on the League of Nations and to look to the reconstitution of such an organization after the War. In December 1942, Mr. Eden, for example, declared that the old League of Nations did not fail because its machinery was faulty but because there was "insufficiently representative force or drive behind it". "There are", said Mr. Eden, "three indispensable attributes for an international organization if it is to have a chance to achieve its purpose. First, it must be fully representative of the Powers that mean to keep the peace; secondly, it is for those Powers themselves to have the unity and the determination to arrive at great positive decisions; thirdly, they should have force behind them to give effect to their decisions".

Much the same line of thought has been discernible in Mr. Churchill's recent references to this question, and especially in his statement in the House of Commons on May 24; while the picture of international organization which General Smuts gave in his broadcast to the United States last December closely resembles in structure the old League of Nations. Within the wider democratic organization of the United Nations, he said, there would be not only a council and an assembly on the existing League of Nations model, but also a definite responsibility on the four great Powers, the United States, the British Commonwealth of Nations, the U.S.S.R. and China, for maintaining peace, at least while the new world organization is being built up. National sovereignty would be respected, but there would be an international regime of law and order which would guarantee to each State a peaceful life of its own, and the aggressor would be dealt with by international authority as an outlaw.

General Smuts firmly rejected the current criticism in the United States that the League of Nations asked too much of its members. He argued that the contrary is true. The obligations imposed by the League

were too indefinite and too slight, and insufficient provision was made for the supply of force. In effect, he accepts the argument consistently used by the French, and supported by several minor European Powers, although opposed by Britain, the United States and Germany.

General Smuts hopes that under the leadership of the four great Powers there will be built a habit of co-operation in the critical years immediately following the War, and that it will become a real basis of future security. In this way would be remedied the lack of will which first wrought the mischief twenty years ago. The question of sovereignty is handled very delicately, but nowhere does he quite put the real issue so plainly as Mr. Wilkie in a recent article, when he urged that the best way for the United States—and other nations—to preserve its sovereignty is to exercise it as part of a world pattern of co-operation.

It will be noted again that General Smuts passed lightly over the common tasks of the new organization outside its police work. Of its economic functions he said little, nor did he touch on the functional proposals which represent one important approach to the organization of peace and are not necessarily inconsistent with his own outline. Nothing in his defence of the old League or in his proposals for a new one holds any support for indulgence by the British Commonwealth once more in an easy peace, which far more than any shortcomings, political or economic, in the Versailles Treaty was our undoing.

That is indeed one of the surest grounds for hope. While the structure of a new world organization is only tentatively outlined, in Great Britain as in America, public opinion is being educated to what is involved and prepared for the demands that must be made upon it for the support of any system of security. Recognition that any structure of peace must be backed by adequate force must be followed by the recognition that adequate force involves the support of adequate measures and policies to provide that force, and a break once for all with the fatal habit of the inter-war years of enunciating principles and proclaiming policies without assuring the means of making them effective.

That means in practice that some joint strategy common to the members of the British Commonwealth and to the other great countries of the United Nations must be planned, and preparations made to put it into execution. Such joint effect should develop the essential habits of co-operation and in time create appropriate organs adapted to the functions they are called upon to perform. Defence, in fact, is only another functional approach to the main problem, and as in so many other fields the most promising line of advance lies in the adaptation to our post-war purposes of the machinery called into being by the dire exigencies of war.

The functional approach to the problem of the organization of world order is not the only way in which new arrangements for international co-operation are already being evolved. The regional approach as exemplified in the Anglo-American Caribbean Commission or the Middle East Supply Centre is fully as important as the functional developments represented by the interim Commission on Food and Agriculture resulting from the Hot Springs Conference, and also the United Nations Relief and Rehabilitation Administration. Both types are consistent with the structure outlined by General Smuts and with the seventeen points of the basic statement on foreign policy of the United States issued by Mr. Cordell Hull in April.

That such proposals do not as yet include any definite provision for either the continuation of the League of Nations as a body entrusted with the co-ordination of the activities of a number of international bodies, or the creation of a new international organization entrusted with such functions, does not warrant any hasty conclusions that what is useful in existing organizations will not be incorporated in a new or remodelled organization. Always provided that the fundamental thought and examination are proceeding, it is no bad thing that time should be taken to formulate proposals for the ultimate structure of the permanent world organization to give effect to the points of the Atlantic Charter and subsequent declarations of the United Nations. The growth of a sense of common purposes and ideals and fellowship which is one of the invaluable results of functional organizations is always a slow process, and on this point Mr. M. R. C. Greaves' "The League Committees and World Order" will richly repay further study.

Uneasiness on this point, which is betrayed both in the long report on "The Future Policy, Programme and Status of the International Labour Organization" prepared for discussion at the Philadelphia Conference, and in the Report on the Work of the League of Nations, 1942–43, submitted by the Acting Secretary-General, may well be unfounded. The International Labour Organisation, it is true, has had to establish with each of the new bodies as it is created working relationships equivalent to those which, during the inter-war period, covered a wide field of international co-operation. Nevertheless, it may well be that the distinctive contribution of the International Labour Organisation to the strengthening of the whole structure of international organization now being evolved may best be made, in virture of its tripartite composition, if the Organisation conceives of its activities on functional lines, and pursues policies and activities in accordance therewith. The Organisation possesses no executive authority, and to press too far into such fields as that of full employment, which call for the exercise of authority in economic matters, may well be detrimental rather than beneficial to its influence.

The creation of functional international bodies for handling world social and economic problems is not an end in itself, but a step towards the achievement of a larger objective. Whatever functional bodies may be established will require effective co-ordination in a general pattern of international economic organization, and this general pattern in turn must be integrated appropriately with the general international organization for the maintenance of inter-

national peace and security contemplated by the Moscow declaration. This point is rightly emphasized in the report on the future of the International Labour Organisation already mentioned, which points out that it may be reasonably assumed that the constitutions of the functional bodies which are being created will be framed so as to allow effective co-ordination of their activities and the ultimate attainment of the larger objective of a comprehensive and integrated structure of world institutions. Failure to achieve such co-ordination must in fact seriously prejudice the efficient operation of such bodies.

While agreeing that a close and organic relationship must be established between the International Labour Organisation and the general international organization of the future, it is urged that the contribution of the International Labour Organisation to the co-ordination of international public policy must be made in a manner which does not involve renunciation of its tradition of constitutional autonomy, which has contributed much to the vitality of the Organisation and is a major safeguard for its capacity to weather future storms. At the same time, the Organisation is itself potentially an instrument through which there can be achieved both a measure of co-ordination of the specialized agencies now being envisaged and an adequate backing from public opinion for their work. Co-ordination of the different fields of international public policy requires, it must be remembered, not only machinery for taking immediate decisions but also machinery for the general exchange of views on objectives and methods of approach. For the fulfilment of this second function the International Labour Conference appears to be a uniquely appropriate instrument, and its experience may well prove invaluable in working out the precise machinery by which expression is to be given to the democratic ideal in the progress towards world government.

The introduction to the Acting Secretary-General's report on the work of the League makes another useful contribution to this discussion of the future world organization. Its summary of representative views shows that the fundamental ideas on which public pronouncements concur are not greatly dissimilar from the principles of the Covenant of the League of Nations, and that certain general principles are gaining recognition. These principles must be accepted as the bases of continuous co-operation and embodied in definite undertakings. There must clearly be a permanent organization, and whether or not the League of Nations itself is reconstituted we should avail ourselves of its experience over a period of twenty years.

The Acting Secretary-General in his report suggests as a useful method of approach the careful examination of the provisions of the Covenant, to determine for each the principle its authors wished to establish and to ascertain whether that principle can now be considered as generally acceptable. If so, past experience should show whether the means provided in the Covenant to give practical application of the principle are sufficient, and whether it was the power and the will to apply them that were lacking.

One of the problems that will require reconsideration in the light of the lessons of the War is that of joint military action. This is one of the novel features of the plan for world settlement outlined by Ely Culbertson in his "Summary of the World Federation Plan"* of which a more detailed account has since been published in the United States under the title "Total Peace". Mr. Culbertson dismisses as fallacy the idea of reviving the League of Nations, although he regards its work as laying the foundations for a new attempt at world order. Mr. Street's plan for Federal Union is also dismissed as premature in the face of the dominant force of nationalism. Co-operation of sovereign nations must precede world federation of nations and the world parliament of man. Neither of these plans takes into full account the revolutionary changes in science, military weapons, communications and economics of our generation; but Mr. Culbertson's "Summary" does not specify the fatal defects of structure which in his view crippled the League of Nations from the start, and the real defect in the Federal Union proposals is probably one of rigidity rather than of timing.

Meanwhile, the League report itself recognizes that structural defects may hamper the development of an institution, however much we agree with Mr. C. J. Hambro that organic growth in itself can never be made to conform to blue-prints but creates constantly new problems. Moreover, if the means placed at the disposal of an international institution are not commensurate with the aim in view, the loftier the aim the greater the risk that the institution may sooner or later meet with a serious failure, which will shake confidence and make reconstruction difficult. Nevertheless, there is some substance in the suggestion of this League report that what is sometimes regarded as the liability of the old name might prove an asset for the new attempt to establish world order, because use of the old name should discourage any tendency to think that the machine of itself would produce results, whereas they can only come from consistent effort and loyalty and goodwill.

Mr. Culbertson, however, is at one with the League report in holding that the future world organization cannot be left over entirely until peace and order have been re-established. The details may be left, as Mr. Churchill has suggested, to be settled after the formidable foes we are now facing have been beaten down and reduced to complete submission. This view was afterwards endorsed by Mr. Eden, who suggested, as one of the five principles on which world organization should be based, flexibility and growth by practice without attempting to work to a fixed and rigid code or rule; but a prior and clear-cut decision as to the revival of the collective security system and guaranteed mutual help might well aid in solving many thorny problems, such as those relating to frontiers.

Mr. Churchill, in his review of foreign policy on May 24, contemplated a world order and organization equipped with all the necessary power to prevent

* Summary of the World Federation Plan: an Outline of a Practical and Detailed Plan for World Settlement. By Ely Culbertson. Pp. 78. (London: Faber and Faber, Ltd., 1944.) 5s. net.

future wars or the planning of them in advance by restless and ambitious nations. That organization would include a world council of the greatest States for the purpose of preventing war, as well as a world assembly of all Powers. Mr. Churchill would not commit himself to the precise relations of these bodies or to the question of united forces of nations as against world police for keeping the peace. He considered that we should undoubtedly embody in our world structure a great part of all that had been gained for the world by the structure and formation of the League of Nations, but within the limits assigned to it we must make sure that our world organization has overwhelming military power. These points were later elaborated by Mr. Eden as three of four principles of world organization, the fifth being that the Powers included should strive for economic as well as for political collaboration.

That is the main purpose of Mr. Culbertson's quota force principle. This is a new system of composition and distribution of national armed forces, based on heavy weapons. The world police, under this system, would be the only force in the world which is armed with heavy weapons (that is, armoured aeroplanes, capital ships, tanks and heavy guns), the manufacture, transportation and possession of which would be the monopoly of the world federation. This police force would consist of twelve separate armies: eleven national contingents recruited from the citizens of each initiating State, and an international contingent, called the mobile corps, of units or regiments, or their naval and air equivalents, recruited from all member States other than the initiating States, and distributed, in contrast to the national contingents, which will be stationed only in their country of origin, only in strategically located islands purchased by the Government of the World Federation and in leased bases in States which participate in two regions. Quotas assigned to the national contingent are based on the industrial power of the initiating State, the extent of the regional territory it must defend and on the psycho-political factor. The international mobile corps would be stronger than the strongest contingent of any initiating State.

This scheme for a double military system is ingenious, and while some points of detail such as the relative allotment of power as between the U.S.S.R., the United States and the British Commonwealth may be hard to justify, it at least merits serious consideration, and represents something which might well develop naturally from the position in which the United Nations will find themselves after the War. It is certainly not inconsistent with the picture of world organization sketched by General Smuts or by Mr. Churchill. For the rest, it may be said that Mr. Culbertson's plan is based on a regional system, the arguments for which are given in his book, "Total Peace"; this may explain some of the inconsistencies which appear to characterize the plan as presented here. Its fundamental assumptions no less than its specific objects are common ground in most discussions to-day on the form of world organization. The substance of them is to be found in the speeches of Mr. Churchill and of Mr. Eden on May 24 and 25. Mr. Culbertson himself, for example, in furtherance of the establishment of world-wide educational, scientific and economic institutions, would embody within the world federation the present agencies which the United Nations, the League of Nations and the larger peace foundations have already established for these ends.

If on the evidence so far presented some of the details of Mr. Culbertson's plan are not entirely convincing, in spite of the serious study which his suggestion for a double military system deserves, to that extent they attest the wisdom of Mr. Churchill's warning against putting forward formally and in too great detail our own views or solutions in a manner which might prejudice their consideration. The importance of democratic procedure in establishing a permanent organization is sometimes overlooked, but without it the consent of all participating nations is not likely to be easily won or held. Nevertheless, though methods and details may vary, through all these proposals, from whatever source, runs the common thread that, as Mr. Eden said in concluding his speech, only by translating into the period of peace the confidence we have built up among our allies in war can we hope to save the world from a repetition of these conflicts. Given the will, courage and elasticity of mind, firmness of purpose, the ability to learn from the past, to adapt to our present and future needs whatever of value existing institutions may hold, there is no room for pessimism. The constructive thought and imagination displayed in these and other speeches and papers show that mankind is capable of providing himself with the institutions necessary to ensure that the fruits of victory are enjoyed, and that the great heritage of civilization, the rights and liberties of individuals, are not again endangered by nationalistic ambitions.

## A SURVEY OF THE UNIVERSE

### The Universe Around Us

By Sir James Jeans. Fourth edition, revised and reset. Pp. x+297+32 plates. (Cambridge: At the Oxford University Press, 1944.) 15*s*. net.

IN the decade that has elapsed since the third edition of this well-known book, many advances in astronomy have been made. Sir James Jeans has incorporated reference to many of these in the new edition, and has taken the opportunity to make a thorough revision and to rewrite a large part of the book. Thus, for example, reference is made to the recent discovery of companions of small mass belonging to the systems of 61 Cygni and 70 Ophiuchi; some account is given of Eddington's investigations on the expansion of the universe and the rate of recession of the extra-galactic nebulæ; and the bearing of the new knowledge of the source of stellar energy, derived from the study of thermo-nuclear reactions, on the evolution of the stars is described.

Thus the book continues to provide one of the best accounts available in simple language of the results of modern astronomical research. A very wide field is covered, for an account of modern

atomic and quantum theory is included; this is a great help to the general reader. The book is written with Sir James Jeans's usual clarity of style and facility of expression. It abounds in apt and striking illustrations and analogies; to give but one example, the statement that the temperature at the centre of a star is about twenty million degrees conveys little to the average reader, but the remark that a pin-head of matter at that temperature would emit enough heat to kill anyone who ventured within a hundred miles of it helps the reader to realize something of what such a temperature involves.

There are a few places where a little further explanation would have been helpful to the lay reader. Thus, on p. 33 it is stated that "in 1814 Fraunhofer repeated Newton's analysis of sunlight, and found that the spectrum was crossed by a number of dark lines"; a reader who knows nothing about the spectroscope but is familiar with Newton's experiment, in which a coloured band was formed by overlapping images of the sun, may be left wondering why the spectrum is crossed by *lines*. On p. 65, it is stated that the rotation of the galaxy makes it difficult to believe in a local cluster of stars, because such a cluster could not be a permanent structure; the reader may object that some of the photographs of extra-galactic nebulæ appear to show many such local clusterings.

On pp. 25, 26 it is said that Ptolemy argued that the earth could not be moving through space because this would involve a displacement of the nearer stars relative to the background of more distant stars; this is misleading, because in Ptolemy's time and for many centuries after, it was believed that the stars were all fixed to a sphere. A motion of the earth would have involved changes in the angular separations of the stars, of the nature of proper-motions, and it was through displacements of this type that William Herschel was enabled to detect the motion of the sun relative to the stars.

On p. 204, referring to the hydrogen content of the stars, it should be mentioned whether the stated percentage is by mass or by volume. The statement on p. 253 that the swarm of asteroids can be explained *quite simply* as the broken fragments of a primeval planet is not correct, if it is meant to imply that it has been proved that the asteroids originated in this manner. Nor is the statement that there are several families of comets the members of which follow one another round and round in the same orbit (p. 256) correct. The explanation of comets as part of the *débris* left after the birth of the planets shelves the difficult question of the origin of comets; several comets have been observed to disrupt, and traces of them can be detected by showers of shooting stars when the earth meets the orbit of the disrupted comet; there is no evidence of any comet having entered the solar system from outside; it seems that the formation of comets must be a continuing process in the solar system, though there is no satisfactory theory to account for this.

But these are minor defects in a book of absorbing interest, which carries the reader through space and time, discusses the evolution of the stars and of the universe, and concludes with a fascinating chapter on beginnings and endings. The black-out conditions during the War have enabled many people to see the glory of the heavens for the first time, and this has brought about a greatly increased interest in astronomy. This book should do much to stimulate that interest.

H. SPENCER JONES.

# ELEMENTARY WAVE MECHANICS

## Elementary Wave Mechanics

Introductory Course of Lectures. By W. Heitler. Notes taken and prepared by W. S. E. Hickson. (Hectographed.) Pp. ii+88. (Dublin: Dublin Institute for Advanced Studies, 1943.) 5*s*.

THERE are many elementary treatises on wave mechanics. Their multiplicity is due perhaps to the fact that there are many ways of approach to this subject or perhaps because, as in the case of a disease for which many cures are advertised, the right treatment still awaits discovery.

The present work is based on notes taken on a course of lectures given by the author. It contains features which distinguish it from similar works and which make its publication well worth while.

It is clearly the work of a lucid teacher, and this is to be expected of the author of "The Quantum Theory of Radiation". It is the work of a writer who can keep the physical principles of the subject in the foreground and at the same time introduce the reader to the essentials of the mathematical technique, with some pardonable short cuts.

The book covers a representative range of problems, including the treatment of the hydrogen-like atoms and the problem of two electrons. Welcome additional subjects of study in a work of this scope are the perturbation theory, exchange degeneracy, the spin wave function and the helium atom.

The uncertainty relations are presented in a way which is likely to lead the student to think of them as peculiar to the quantum theory. The sense in which this is true is stated by the author (p. 13), where he writes: "Classical mechanics holds for heavy bodies, the uncertainties are a peculiarity of quantum mechanics which applies to light particles". It is, however, advisable that the student should be aware of Rayleigh's conditions of optical instruments, some simple examples of which can be explained from his knowledge of physical optics. This line of approach has some justification in the history of the development of the uncertainty relations and avoids the tendency towards over-emphasis upon the application in wave mechanics.

It is to be regretted that the wave-length of the particle waves is described as being inversely proportional to the particle velocity although this is true in the limited application considered. It is preferable to describe the wave-length as inversely proportional to the momentum, since this is a true statement both in the classical and relativistic cases.

The author attempts to lead the reader very gently to the idea that the particle velocity has its counterpart in the group velocity and not in the phase velocity of the waves. The attempt seems rather laboured and leads to the strange result that the phase velocity is half the group velocity. This may lead to confusion later on when the question has to be further considered.

The work is to be recommended to degree students who require a clear statement of the principles of the subject and a knowledge of how they are applied in practice. The syllabus chosen is excellent and affords a useful guide to teachers of the subject.

With the correction of some misprints and amplifications here and there, the work will become a valuable introductory text-book.

H. T. FLINT.

## Catalogue of Union Periodicals

Vol. 1: Science and Technology. Edited for the National Research Council and National Research Board by Percy Freer. Pp. xvi+525. (Johannesburg: University of the Witwatersrand, 1943.)

THIS catalogue covers the periodicals of seventy-seven libraries in the Union of South Africa which have agreed to co-operate in inter-library loaning. While it should primarily facilitate such loans and thus materially aid the war effort in South Africa, it is also an important aid to reshuffling so as to place the most complete sets in the larger centres. The catalogue renders comparatively easy the compilation of a national list of desiderata of those important titles of which no sets or only poor sets exist in any South African library, and besides eliminating unnecessary duplication it should encourage co-operative purchase to fill the lacunæ thus revealed.

The catalogue includes many titles which are too recent to be included in the World List of Scientific Periodicals, and for that reason and also on account of the subject classification it may be found a useful guide to the existence of scientific and technical periodicals, although not for loan purposes, by scientific and technical librarians in Great Britain.

The present catalogue contains more than 6,000 entries as against 3,117 in A. C. G. Lloyd's List of 1927. The abbreviations used in the World List of Scientific Periodicals are used wherever possible and emphasized by underlining. The primary arrangement is by subject, and the sub-arrangement first by language, and second by country. Where no subject is expressed the main entry goes to the name, for example, Carnegie, Faraday, Franklin, Smithsonian, with cross-references from institutes and societies. Other main entries are under distinctive titles, while where no subject is expressed with academies, institutes or societies the main entry goes elsewhere, for example, to institutes, laboratories, museums, etc. Entries closed on September 30, 1941, and participating libraries are now invited to maintain a list of additions and corrections for quarterly publication in South African libraries.

## The Weather

By George Kimble and Raymond Bush. (Pelican Books, A.124.) Pp. 188+24 plates. (Harmondsworth and New York: Penguin Books, Ltd., 1943.) 9*d*. net.

## Meteorology

By Lieut.-Colonel R. M. Lester. (Complete Air Training Course, No. 4.) Pp. 64+4 plates. (London, New York and Melbourne: Hutchinson's Scientific and Technical Publications, n.d.) 2*s*. 6*d*. net.

"THE WEATHER", by Kimble and Bush, must be one of the best nine-pennyworths extant. It is chatty and inconsequential, but when one comes to the end and looks through the index, one realizes that it holds a great deal of solid information; even the reader who follows the suggestion to skip the introduction will miss a great deal. The structure of the atmosphere, instruments, clouds as weather forecasters, depressions and anticyclones are all dealt with simply but effectively; then follow the seasons, 'one-man' forecasting and some oddments like weather cycles, all illustrated by many rhymes from folk-lore, some clear diagrams, and twenty-four excellent cloud photographs. There are one or two errors, such as that a halo grows in diameter as the cloud lowers, but on the whole, readers—and we hope they will be many—will obtain a very good grounding in meteorology.

Lieut.-Colonel Lester's little book is chiefly remarkable for its surprising statements. Its quality may best be shown by a few quotations: "No two snow crystals are ever alike. When one considers the millions of crystals that fall in a snow-storm, this is an amazing feat of nature." "Rainfall is greater at high altitudes. This is caused by the air coming into contact with the cold surfaces of these higher regions." Cyclostrophic effect in wind. "This is the deviation of its flow further from the curved path through the gyroscopic properties of the air mass." "A satisfactory type of rainfall gauge is a brass tube of just over two inches diameter inside an eight-inch cylindrical can."

C. E. P. BROOKS.

## Quantitative Chemical Analysis

A Student's Handbook. By Prof. Joseph Reilly and Eileen A. Moynihan. Pp. x+116. (Cork: Cork University Press, 1944.) 7*s*. 6*d*.

THIS is a very carefully written and good introduction to quantitative analysis by teachers who have evidently had much experience in presenting the subject to students, and have the ability to write a clear and concise account of all the details of the laboratory work which are essential to success. It includes both volumetric and gravimetric analysis, and the examples chosen are very good. The main emphasis is practical; the chief fault of many books, that of writing an elementary treatise on physical chemistry interspersed with a few practical exercises which are generally quite inadequately described, is avoided. The relevant theory is always given, but in its proper proportion, and the result is a very good practical manual which will make easier the work of teachers who adopt it.

The standard of the book is between the intermediate and final of most university degree courses. An appendix describes a method of phosphate separation in qualitative analysis by means of zirconium oxychloride which is an improvement on the usual procedure by this method.

## Martindale's The Extra Pharmacopoeia

Twenty-second edition. In 2 vols. Vol. 2. Pp. xxxiii+1217. 27*s*. 6*d*. Supplement to Vol. 1. Pp. 48. 2*s*. (London: The Pharmaceutical Press, 1943.)

THE second volume of Martindale continues to provide modern and reliable information on drugs and their assay, biochemistry, bacteriology, nutrition and therapy in general. The material provided is as up to date as is compatible with the time necessary to compile and produce the book. The sulphonamides and the vitamins, on which much recent work has been done, are well documented, but the short notes on penicillin direct attention to the rapidity of progress in this field.

As a book of reference for the clinician, pharmacologist and research worker "Martindale" is already well established, and the new volume will deserve the reputation of its predecessors.

The supplement to Volume 1 records changes in, and additions to, the British and United States Pharmacopoeias and National Formularies. There are also notes on recent Orders affecting supplies of drugs, new proprietary names and approved names of substances.

# JOHN DALTON, 1766–1844

By DR. J. NEWTON FRIEND
Central Technical College, Birmingham

ON July 27, 1844, at the ripe age of seventy-eight, John Dalton passed peacefully away in Manchester. Local feeling was stirred to its depths; it was unanimously agreed that nothing less than a public funeral could express the reverence felt for the memory of so great a man. This was the more remarkable since Dalton was a strict Quaker and as such was opposed to official ceremony. His remains lay in the darkened town hall, where some 40,000 people paid homage before interment took place in Ardwick Cemetery on August 12.

So many biographies and sketches of the life of Dalton have been published from time to time that it would be superfluous to labour the details in these columns. Suffice it to say that Dalton was born, probably on September 5, 1766, of humble parents in a thatched cottage in the secluded Cumberland hamlet of Eaglesfield, some half a dozen miles from Cockermouth. The cottage still stands, the thatch replaced by slate, and a suitably inscribed commemorative tablet has been inserted above the door. Fig. 1 shows the cottage with the tablet. Fig. 2 shows the Friends' Meeting House at Eaglesfield (where Dalton worshipped) as it appeared in 1895. In the foreground stands Mr. Norman, the oldest inhabitant of the village and the only one who then remembered seeing Dalton.

At an early age Dalton showed unusual industry and talent; when a mere lad of twelve, he began to teach the village school in a barn, but discipline was difficult as his pupils included boys and girls several years older than himself and far more interested in each other than in their lessons. Three years later (1781) he joined his brother as usher in the Friends' School, Stramongate, Kendall, run by his cousin George Bewley. The school had been founded in 1698 and continued until some fifteen years ago, when it was closed down. It is still an educational institution, being used in part as an elementary school for senior boys and in part as school and dental clinics*.

Dalton appears to have been but an indifferent teacher, too much absorbed in his scientific pursuits to worry unduly about the progress of his pupils. About this time he gave a few lectures also to adult audiences, but Dr. Henry states that he was never an attractive lecturer. He seemed unable to devise really impressive experiments, and failed as often as he succeeded in carrying out even such elementary experiments as he did attempt. Nature seldom puts all her eggs in one basket.

While at Kendall, Dalton discovered that his idea of colour was abnormal—he was colour blind. To him pink appeared as blue, and a waggish friend suggested that this might be the cause of his remaining a bachelor, the pink cheeks of a maiden giving him "the blues".

* I am indebted to the Town Clerk of Kendall for this information.

In 1793 Dalton went to Manchester, where he entered upon a period of great scientific activity. It was here that, in 1803, he announced his Atomic Theory, which revolutionized our outlook on chemistry, rapidly raised him to the pinnacle of fame and earned for him the title of 'father of modern chemistry'. Honours of various kinds were showered upon him, but none affected his rugged character or his genuine native simplicity. In the words of Millington, one of his biographers, "even after all his triumphs and scientific achievements, he was at heart the simple countryman of frugal tastes, speaking the broad dialect of the Cumberland fells".

Dalton's interests, however, were by no means confined to physics and chemistry. In 1844, having been a member of the Manchester Literary and Philosophical Society for fifty years and occupied the presidential chair for the last twenty-seven of these, he presented his fiftieth annual meteorological report, having then made more than 200,000 separate recordings. He once (1801) wrote a book on English grammar. In this he pointed out that, while logically there can only be two tenses, past and future, it is convenient to regard the immediate past and future as the present. In his treatment of gender he was less fortunate; few will accept his dictum that "phenomena" is the feminine version of "phenomenon".

FIG. 1.

In 1804 Davy invited him to lecture at the Royal Institution. Dalton evidently thought highly of Davy, referring to him as "a very agreeable and intelligent young man", but added that his habits were marred by one serious defect, to wit, he did not smoke! Six years later, Davy suggested that Dalton should offer himself as a candidate for election to the Royal Society, but Dalton did not do so, possibly because the fees were too high for one holding so meagre a purse. He never laid himself out to make money; for him money was merely a means to an end; otherwise he had no use for it. Thus in 1818 he was invited to join the Arctic Expedition of Sir John Ross at a salary of £400–£500 a year. This would have been nothing less than a fortune to Dalton; nevertheless he declined on the ground that he did not wish to interrupt his scientific investigations.

FIG. 2.

In 1822, however, Dalton was elected a fellow of the Royal Society; he also visited Paris, making the acquaintance of Laplace, Thenard, Ampère, Berthollet, Gay Lussac and numerous other savants. Alas, he could not meet Lavoisier. Ten years later he received the degree of D.C.L. at Oxford, along with his famous contemporary Faraday. In 1833 effect was given to a proposal of Charles Babbage, of calculating-machine fame, and he was awarded a Civil List pension of £150 a year, afterwards raised to £300. Meanwhile, Manchester decided to erect a statue in his honour, and that was duly completed. It still stands in the entrance to the Manchester Town Hall. In the same building is a mural painting by Ford Madox Brown depicting Dalton collecting marsh gas for his analyses. In 1834 Edinburgh conferred on him the degree of LL.D. and in the same year he was presented at Court to King William.

In a codicil to his will, Dalton bequeathed all his chemical and philosophical apparatus to his pupil and friend, Dr. William Charles Henry, who in 1854 published his well-known "Memoirs of the Life and Scientific Research of John Dalton".

Turning now to the theory which has made Dalton famous for all time, it may be well to remind ourselves that Dalton was not, and never claimed to be, the first to postulate an atomic theory of matter. Early Hindu literature shows that such a theory existed so long ago as 1200 B.C. Matter was regarded as an aggregation of minute, discrete particles which, though separated from each other by empty space, contrived to attract one another with sufficient force to account for the ordinary phenomena of cohesion. In later years the Greeks held similar views; we do not know if they borrowed them from the Hindus or arrived at them independently; they did, however, go a little further in that they regarded the particles as indestructible and always in motion. Democritus (460–360 B.C.) was an early exponent of these ideas, which at first were by no means popular but later came to be generally accepted.

Although useful to the physicist, the theory did not offer much help to the chemist, largely because it was purely qualitative in character. In the fourteenth century, Al Jildaki (died 1360) observed that "when substances react they do so by definite weights". Had this quantitative conception been suitably linked up with the atomic theory, our Law of Equivalent or Combining Weights would have been anticipated by several centuries. But the time was not ripe and the observation appears to have been forgotten. It required a Dalton to bridge the gulf.

Dalton's Atomic Theory is usually summarized as follows:

(1) The atoms of any one element are all alike and possess a definite and characteristic mass. They differ from the atoms of any other element both in their physical and chemical properties.

(2) Chemical compounds are formed when the atoms of two or more elements unite in simple chemical proportions.

Once these postulates are accepted, the Laws of Definite Proportions, Multiple Proportions and of Equivalent Weights become self-evident.

The exact manner in which Dalton arrived at his theory has been a matter of dispute, into which we need not enter. It may well be that the idea gradually crystallized in his mind as the result of prolonged thought in various directions. Neither need we worry because we now know that the theory, as given above, is not correct in detail. Thus, owing to the existence of isotopy, the atoms of any one element are not of necessity all alike; also, atoms do not always unite in simple numerical proportions when compounds are formed, as witness albumen and gelatin, to which reference is made below. The important point is that the essential feature of the theory is correct. It would not be difficult to re-state it, if such procedure were deemed necessary, to harmonize more closely with modern conceptions of matter. But a theory need not be correct in detail in order to be useful, and it is mainly by its use that we judge it.

One immediate advantage of the theory lay in the possibility it afforded of designing formulæ capable of indicating both qualitatively and quantitatively not merely the composition but also the constitution of chemical entities by means of symbols and formulæ. Hitherto, symbols had been used by the alchemists, more or less as cryptic labels, to denote various substances. Thus a circle denoted gold, a wavy line represented water, and so on. But such symbols gave no indication whatever either of the quantities involved or of the composition of the substances. Dalton denoted atoms by circles, suitably modified to distinguish between different elements. Thus ●○ represented a molecule* of carbon monoxide. As each circle denoted one atom of carbon and oxygen respectively, the formula clearly gave the amount of the gas present and its composition. When several atoms are united in a molecule, it may be possible to arrange them in different ways, yielding compounds with different properties. It is not generally known that Dalton himself realized this. He believed it to be the case with albumen and gelatin, which he formulated as

albumen gelatin

(that is, $C_2H_2ON$).

* We are ignoring the fact that at first Dalton wrote oxygen as ⊙ and afterwards altered it to ○; also that he used the word atom very frequently where we to-day would write molecule.

The example was unfortunate, for these molecules are far more complex than Dalton realized. This fact, coupled with the introduction of the simpler Berzelian notation, which led to the writing of empirical formulæ, such as $CO_2$ instead of the structural ○●○ (or OCO), caused Dalton's observation to be overlooked. Consequently when later chemists discovered true examples of isomerism, Dalton's contribution had been forgotten.

The question now arose as to how the union of atoms could take place. The first suggestion that atoms possess mechanical hooks was very natural at the time but was soon found inadequate. The connexion between chemical combination and electrical forces was then just beginning to be realized, for Nicholson and Carlisle had already in 1800 decomposed water electrically. In his Bakerian Lecture to the Royal Society in 1806, Davy formulated a qualitative electrochemical theory of chemical combination which was improved upon by Berzelius in 1812; but curiously enough, attention was focused more on the combining power of groups of atoms (radicals) than on individual atoms themselves. It was not until eight years after the passing of Dalton that Frankland introduced the conception of an atomic attractive power, that is, valency. The gate was thus opened to an enormous field of research on atomic forces and molecular structure, the confines of which even now appear to recede, like the end of a rainbow, the further we progress.

The foregoing may be regarded as some of the more immediate consequences of Dalton's theory. But the tale is not complete even yet. The atomic theory has migrated into realms undreamed of by its creator, and has opened up avenues of approach to problems the immensities of which appear to grow with each succeeding age.

In his brilliant researches, Faraday showed that electrically charged atoms or groups of atoms can exist in solution; he called them 'ions' and in 1835 enunciated his Laws of Electrolysis. It was inevitable, therefore, that the atomic conception of matter should eventually be extended also to electricity. This was first clearly done by Johnstone Stoney in 1874, who named the 'atom' of electricity an electron, and pointed out that $Ne$ is Faraday's ionic charge for a univalent ion, $N$ being Avogadro's number and $e$ the 'atom of electricity', that is, the electronic charge.

But if electricity is atomic, what about other forms of energy? The breakdown of classical methods of calculating the intensity of radiation of a black body at various temperatures led Planck in 1900 to extend the atomic idea to energy in general. He suggested that bodies can only emit radiation in discrete portions or quanta—atoms of energy. This enabled him to draw up an expression that would account completely for the observed distribution of energy in the temperature-radiation spectrum. He was also able to explain the lack of agreement between the classical formulæ of Wien and Rayleigh, and to show that these formulæ represent extreme cases of his own universal expression.

Five years later, Einstein explained photo-electric effects as due to 'atoms of light' or photons; in other words, light waves possess atomic characteristics.

Limitations of space forbid further discussion of these themes. Sufficient has been said, however, to show that Dalton's Atomic Theory has proved one of the most fertile ever propounded. Just as a crystal dropped into a solution may yield a vast crop of crystals entirely unrelated in quantity to the size of the original crystal, so Dalton's theory has been a nucleus around which have collected, and are still collecting, new laws, hypotheses and theories.

# MEN AND SCIENCE IN THE SEA FISHERIES*

By MICHAEL GRAHAM

In 1863–65, Huxley, as a member of a Royal Commission, on fisheries, made a tour; and I cannot do better than quote a report in his own words on one of the places visited—the Isle of Skye. "He would mention an occurrence which made an indelible impression on his mind—the total earnings of one of those peasants, he might say his whole property and everything belonging to him, would not come to more than £5. Certain interested parties in Glasgow . . . had got a law smuggled through the House of Commons, where nobody cared anything about it, by which it was made penal to catch a herring during the three summer months of the year, a time at which herrings were swarming in innumerable millions . . . that meant that [a man] might be totally ruined or might be put in prison for doing this. . . . Now there was not the smallest imaginable reason why that enactment should have been passed. It was a stupid, mischievous and utterly useless thing. . . . That appeared to be one of the worst forms of modern oppression."

I cannot find words to express my admiration for this passage, of which I have given only excerpts. There the man of science, quite sure of his ground, raised his voice against arrangements that were not based on scientific facts; and in this cause he used all the power of the English language to convey meaning and feeling. Reading it to-day has a reviving effect, by contrast with the polysyllabic jargon of good intention, among which so many of our modern aims meander, and are lost.

This visit of Huxley's led to the Act of 1868, by which most of the restrictions on fishing were abolished; and it set the policy of no restriction without scientific justification which has ruled Britain ever since, and affected millions of lives and fortunes. Such is the power of the scientific attitude, in a bold and able man.

A second notable event in the history of British fisheries was an International Fisheries Exhibition and Congress in 1883, presided over by Huxley, who was now president of the Royal Society. The exhibits included a very good one from the United States Bureau of Fisheries, which was at that time pre-eminent in knowledge of life in the sea, owing to the inspiration of Agassiz. This exhibit aroused great interest among British scientific men, of whom Ray Lankester was one, and it led to their signing a memorial calling for organized marine research in Britain. Their feeling formed one of the major trends at the Exhibition.

A second noticeable trend, closely connected, was the demand from Mr. James Alward, and from other good skippers, for research into the biology of the fish themselves; and a third trend, voiced by the

* Substance of a discourse delivered at the Royal Institution on June 9.

fishermen and by the younger men of science, was one of contention with Huxley and the Civil servants on the fundamental problem. Huxley said: "Nothing that we do seriously affects the number of fish. And any attempt to regulate these fisheries seems consequently, from the nature of the case, to be useless." Finding the truth on this third question called for what we may call 'population studies'.

It seems to me that there were very sensible people gathered at that Exhibition, sixty-one years ago; and that the time is overdue for something of a progress report.

Looking first at the branch that was inspired by the American exhibit, we see in the past sixty years an enormous accumulation of knowledge, and an increase of certainty. Many of the thousands upon thousands of species of animals and plants in the sea have been described, named and classified. The majority of these are in the plankton, that is, the free-floating population, mainly of very small animals and plants, which are found principally in the surface and near-surface layers of the ocean, and in the shallower seas in all layers. Even those animals whose habit is to live near the bottom or near the shore, with few exceptions, begin life as members of the plankton. Besides their structure, something is also known of the behaviour of these animals and plants. Although their active motion in the horizontal is very limited, they appear to have some control over the layer at which they swim, and undertake more or less regular daily migrations—generally to the surface at night and to deeper layers by day. The surface and deeper layers of water often move differentially. Thus by the movements of horizontal layers of water, plankton organisms do effect some horizontal movement, almost like balloonists. It also seems that some of them settle on or very close to the bed of the sea at times, leaving it at others. But there is much about the behaviour of plankton that is still unknown.

It is also now known that the major seasonal changes in numbers of the plankton are closely related to the supply of nutrient salts in the water; shortage of nitrate, phosphate and silicate being liable to limit the growth and multiplication of the plant forms. Here too, though, there is much that is unexplained. Knowing also that the supply of these nutrients varies with the great water movements, which in their turn are correlated with major meteorological changes, investigators are reaching out to a statement of correlated fluctuations—in weather, fisheries, agriculture, water and plankton. This much indeed is known, that particular species are found in different water masses, and their presence denotes an incursion of that kind of water. An example is afforded by three species of the arrow-worm, each of which is confined almost entirely to one kind of water—inshore, Atlantic, or mixed coastal.

Turning to the animals that live on the bed of the sea, it is now known that these tend to occur in more or less well-marked ecological communities, depending on the nature of the ground; but that their numbers are liable to great fluctuations according to the variations in the current that carries the larvæ.

As an example of the application of this general marine natural history to fisheries, we may remember that great concentrations of some of the more spiky diatoms have been found to exclude herring from the normal fishing grounds; and that a start has been made in providing guidance to the fishermen accordingly.

Principally, though, the researches that have provided all this knowledge are to be regarded as research for its own sake, rather than as yielding this or that means for directly making a profit; and I would add that without the confidence that the main lines of nutrition, competition and mortality have been brought within human ken, I for one would not feel bold enough to make the recommendations that come from more closely applied researches. Pure research reveals the background, and the background enables the applied research worker to use judgment, which he would otherwise be quite unable to do for lack of perspective—and judgment is the most valuable weapon that can be provided in practical matters.

For a progress report on the first requirement stated at the Exhibition, general marine biology, there is ample material with which to satisfy our predecessors. This is largely to the credit of the laboratory of the Marine Biological Association and of its many relatives. I think that Huxley, Ray Lankester and Alward would all be reasonably pleased.

The second requirement was knowledge of the life-history of the food fishes—cod, haddock, plaice, hake, herring, and other less quantitatively important kinds, such as sole, turbot, whiting, mackerel and sprats. Here progress was slow at first, mainly for two reasons. First, researches were mostly confined to the waters near the shore. Observations in bays and inlets were valuable, but they could not be generalized to the much greater population of fish which the fishermen were taking in the open sea. It is true that occasional voyages were made in commercial trawlers, and these are, and always will be, necessary as part of the work of a fishery naturalist because that is the only way in which the naturalist can sample the world of fishing methods and people. Without intimate knowledge of fishermen's methods and aims, a naturalist cannot read truly the fishery statistics, which can provide him with a wealth of valuable material; and unless he sees for himself what fishermen are doing, he cannot have a true conception of whether they would in practice carry out his recommendations.

But we are now considering the natural history of the fish, and here the restriction to inshore studies, with occasional voyages as the guest of the fishermen, could never produce adequate answers. For example, it was a canon of the earlier investigators that the inshore area provided the nursery for the tiny cod of 2–3 in. length, because in the late summer these could nearly always be found in the rock pools. The truth of the matter was, however, found to be very different. Some young cod are indeed found on the mile or two strip of coastline available to the earlier investigators, but the nursery area for the North Sea, as a whole, includes the Dogger Bank to Fisher Bank area, and all the grounds to the south and east, which amounts to more than a third of the whole North Sea. This information was only obtained by several expensive voyages of a large trawler fitted for research.

There are many other examples of the necessity for large-scale operations to determine essential facts in the natural history of fishes. Nowhere has this been better shown than in the matter of growth. One of the very important discoveries since the Exhibition of 1883 was that the various hard struc-

tures in fish—bones, scales or otoliths—showed rings on them corresponding with the age of the fish. This discovery, or rediscovery, was made by Hoffbauer in 1892 for carp, and at the beginning of this century it was being applied to the sea fishes. Not all the scales give correct readings in temperate waters, but most of them do, and the record of winter on the scale is on the whole more reliable where the winters are more severe. With the aid of these structures the average age of all the fish in a sample can be determined. In addition, the growth of the fish in past years can also be found by measuring the growth on the scale.

My seniors have told me how at first they expected to find a characteristic growth-curve for each species —the cod, the herring, the hake and so on. This, however, eluded them; samples of cod from Iceland showed a different growth from those in the North Sea, and similar differences between different regions prevail in every species. Even in nearby regions there are differences: the growth-rate of plaice in the English Channel exceeds that of plaice in the North Sea. Recent work has shown that within the North Sea itself there are divisions: in summer a thermocline, or discontinuity in the water layers, becomes established over the deeper parts of the North Sea, denying the warmth of summer to the bed of the sea; and on grounds in that area the growth-rate of cod and of haddock is about half that in the shallower regions.

Furthermore, the growth-rate is not the same from year to year, but varies inversely with the density of the fish on the ground.

A very interesting experiment was carried out by G. T. Atkinson in the early years of this century. He brought back some plaice from the Barents Sea, from crowded grounds which had only recently been found by the English trawlers. Otoliths of plaice from there showed very slow growth. Those of his captive fish that survived, in his barrel of water on the deck of a trawler, he marked and let go near the Dogger Bank. When the marked fish were again caught it was found that they had enjoyed a new lease of life, and had started to grow with the fast growth characteristic of the ground where they had been liberated. Rather earlier, it had been discovered that removing plaice from the crowded nursery grounds of the Dutch coast to the better and more thinly populated feeding grounds of the Dogger Bank resulted in doubling their growth-rate.

All this variation has meant that determination of average growth-rate of fish became a statistical problem of alarming proportions, and it took many years before naturalists could fairly say what the growth-rate is in many regions, under various conditions. Certainly we have lost the old aim of determining a growth-rate characteristic of each species; but, curiously enough, generalization is possible in another way. In one region, the North Sea, under its normal heavy fishing, we can speak for all the important species together. For cod, haddock, plaice and herring, we can say that a good fish, by housewifely standards, is five years old, a notably large fish is ten years old, and a notably aged (and not very palatable) fish is twenty years old.

In most of these studies the only method by which generalization has been possible has been by use of the statistics of the markets. On our English and Scottish fishmarkets are found fish from every part of the North Sea, from the western waters as far as the Atlantic slope, from the Arctic as far as the ice. These fish are recorded by special men in the markets and the place of origin is noted. When all these returns are put together and summed, a series is provided by which the observations of naturalists in particular localities or seasons can be weighted, and so integrated. In this way it has been possible to trace out the main spawning areas and seasons, the main migrations, the main growth-rate and the main areas of immature but catchable fish. So have commercial statistics made possible the solution of problems in natural history.

I put the absence of good statistics as the second barrier to progress in the early years of the science.

It would not, however, be correct to suggest that inshore researches have contributed little or nothing to knowledge. That is far from being the case. Where those researches have led to the statement of a principle, this has been found of general application. Thus sea creatures tend to move upstream to spawn —this is true for the crabs of the east coast of Britain, for cod, plaice and many other fish in the North Sea, for salmon in rivers, and even for eels in the Atlantic Ocean.

Migration before spawning is connected with a period of helpless drift in the life of the eggs and larvæ, which is part of the life-history that has only been traced out by special voyages of investigation, and of which still too little is known. It is tolerably certain that the fluctuations in numbers of the fish population are determined during that six to ten weeks of life in the plankton, but the factors in the process have not been evaluated.

By this kind of research, repeated for many species of fish in different regions, the position has been reached that we know the outline of the natural history of nearly all the populations of fish in the northern hemisphere that provide the staple sea fisheries—and something of those in the southern hemisphere.

I think that the shades of Huxley, Ray Lankester and Alward would take a good deal of interest in this progress since 1883. The requirement stated for thorough investigation of the life-history of the food fishes has, in fact, been met. The only criticism that I can imagine them making would be that it would have taken thirty years instead of sixty if they had had a hand in it.

I should expect, however, a good deal of trouble with Huxley over the third requirement—what I have called the population problem of fish and fishing. My first statement here would be that, far from the catch being an inconsiderable proportion of the stock of fish in the sea, the industry has now grown until, for heavily fished stocks such as the plaice, cod and haddock of the North Sea, the catch in this century has become about 70 per cent of the fishable stock.

Here I should, rightly, be challenged to produce the evidence for a statement that presumes to know the number of fish in the sea; and I should say that there are two independent lines of evidence which agree in making the catch of that order of magnitude. First, naturalists of all countries have marked large numbers of plaice and cod with numbered buttons, and let them go in the sea again. The same has been done for halibut in the Pacific and for several other species in various parts of the world. Marking fish has been a most fruitful technique; and fishermen have become well used to recognizing marked fish and returning the mark, or both mark and fish, to our officers at the ports. With due precautions and

adjustments for lost marks, the percentage of fish liberated that is returned to us through the commercial fishery is an index of the percentage of the stock that the commercial fishery takes. That is the first line of evidence. The second is this. In the 'nineties, Henson and his colleagues started to sample plankton quantitatively, including the floating fish eggs. In the hands of Buchanan Wollaston, particularly, this method has been developed, until an estimate of the total number of eggs liberated in a season can be made. This number of eggs can be converted to the number of mature female fish, and that again to the number of fishable fish of that species in the sea. From the commercial statistics we can estimate the number of fish in the catch; and so we have an estimate of the ratio of catch to stock.

Both these estimates have only been possible for one population of fish, the plaice in the North Sea. However, in the commercial statistics of cod and haddock there are certain signs, namely, the fall in the catch per unit of fishing power, the increasing scarcity of older fishes in the catches, and the recovery that these stocks make when fishing is interrupted, all of which indicate about as high a rate of fishing on haddock and on cod in the North Sea as on the plaice, for which our special technique has given a numerical estimate.

So, the nature of the case, from which Huxley argued, is by now very different from what it was in the past. Already, in those days, the catches of the deep-sea fishing smacks were showing a noticeably smaller weight of flat fish caught per vessel than had ruled formerly, and the same phenomenon has continued since, in every fishery where the fisherman has power at his command, and is not limited by his market. This phenomenon, reduction in weight caught per unit of fishing power, is a very common one all over the world. It undoubtedly shows a reduction in the weight of fish in the sea, and a reduction in the return to the fisherman per unit of effort.

By way of an example let me quote what I believe to be the very earliest statistics to show this phenomenon.

CATCH PER TRAWLER PER ANNUM OF SOLES AND BUTTS

| | Tons | cwt. | To the nearest ton |
|---|---|---|---|
| 1864 | 15 | 5 | 15 |
| 1865 | 11 | 15 | 12 |
| 1866 | 9 | 4 | 9 |
| 1867 | 8 | 10 | 9 |
| 1876 | 4 | 14 | 5 |
| 1880 | 5 | 1 | 5 |
| 1881 | 4 | 19 | 5 |
| 1882 | 5 | 15 | 6 |

The story is just the same wherever a fishery has developed.

It is evident, therefore, that if a fisherman is to continue to earn a living, he can only do this by increasing his efforts. He must work harder, and invent new and better fishing gear, or use a larger or faster ship. In that way each man can continue in business. But, of course, this reduces the weight of the stock still more.

I have talked of the weight of the stock in the sea being reduced, but in all fisheries where there are good statistics this has not at first meant any reduction in the total weight landed each year. On the contrary, the fishery as a whole grows each year at first. But experience has shown that the process does not continue indefinitely: there comes a stage where an increased effort produces no increase in total weight caught; and in fact there are many fisheries where a decrease has followed.

At the stage when increasing effort produces no greater catch commercial depression sets in, and becomes chronic. I am here only describing known facts, but facts that were unknown in 1881, and not conceived possible by Huxley and by those who thought with him.

I will not here recount the mechanics of this characteristic process—a falling weight per unit of effort, and a total yield that first rises, then rises no more, and sometimes falls: but it is in fact all explicable in terms of the growth-curve of individual fish, and of the rate of mortality by fishing and the rate of mortality from natural causes. These relations have been demonstrated in papers written since 1935, or before, and are thus well established. A broader explanation is probably of more use here. I can put it this way. You can fish at a *high* rate and take a large percentage of stock kept *small* by that high rate, or fish at a *low* rate and take a small percentage of a stock allowed to grow *big* by that low rate. Or you may have your equilibrium at any point in between—or so it seems to me; because I believe that the multifarious systems of animals and plants behind the fish stock can nourish young fish or old using different food chains. The catch is therefore stock × fishing, with one going up as the other goes down. Personally, I do not find it at all surprising that extremes of values of the factors give a less product than intermediate values of both.

If, for the present purposes, it is allowed, on the grounds as it were of symmetry, that moderate fishing will give the greatest yield—and the student who has more time at his disposal may check the precise evidence for that conclusion—then some very serious and far-reaching consequences follow.

Let us look at a commercial consequence first. It is necessary to explain that the great steam-trawling industry of Britain has expanded by adventure—that is, by successive exploitation of new grounds, always farther and farther afield. In the years preceding the War, the far Arctic was the new Eldorado, where the cod was still at an early stage of the fishery, where the more you fish, the more the total catch rises. But on all the nearer grounds, such as the North Sea, Irish Sea, and Atlantic Slope, the total catch has ceased to rise long ago.

Yet the traditional psychology of pursuit remains, and whenever these near-waters fisheries appear promising, more ships, or better gear, or better fishermen, immediately engage.

Experience shows that this may be successful for a little while, as when new trawls were profitable in the North Sea for about three years from 1924 onwards; but of course the new effort drives the stock down to a new low level, and the fishery is unprofitable again.

So the net effect of the psychology of adventure is to give an average equilibrium, governed only by the equation:

$$\text{Average profit} = \text{nil}.$$

This is what happened in the Dreary Thirties—as there is ample independent evidence from account books to prove.

The Great Law of Fishing is that unlimited fisheries become unprofitable. It is clear that the

only adequate measure to conserve the fishery is to set some limit to the amount of fishing. The alternative is what we have in fact seen, the history of boys not being so unwise as to join an industry where unexampled hardship is coupled with such unattractive prospects.

However, the moment you agree to set a limit to fishing power, you find that you have in practice taken on responsibility for the way of life of the fishermen—and that brings me to the social consequence of the natural law of the stock of fish. Here it seems to me that Huxley would be on my side. He had such a practical and clear-sighted appreciation of arrangements as they affected people, as he showed in his statement of the position of the crofters, in the passage that I have quoted.

No one likes ordering the lives of other people, but control forces us either to order them or to disorder them; and to order them seems to me to involve fostering all the qualities that we admire in them. Thus we could foster individual enterprise, inventiveness, skill, technical improvement, better conditions, and any other thing that we know to be good.

Thus it seems to me, at any rate, fishery science has in these sixty years since the Exhibition brought in the power of knowledge. I do not suppose that we have more than a first approximation to the truth yet—in many departments of the science—but we have that approximation established beyond any doubt whatever, and we know exactly what has to be done.

In 1868 the scientific attitude liberated the fishery from unnecessary regulations, and allowed it to become great. But the industry has now reached the bounds set by Nature, and science, which allowed the child to grow to manhood, has now the knowledge to say what is proper in a mature industry, dependent on a natural resource.

## SYNTHETIC RUBBER PROBLEMS

THE chairman of the Division of Rubber Chemistry of the American Chemical Society, at the spring meeting of the Division in April in New York City, well said that while the achievements of rubber technologists with natural rubber in a hundred years of progress are a subject for just pride, the actual production work with synthetic rubber in less than a hundred weeks is nothing short of a miracle.

Nevertheless, the processing problems involved in using *GR–S*, which is the butadiene–styrene polymer mass-produced in the United States to replace the million tons of natural rubber in enemy hands, are still numerous, difficult, and of serious significance to the available output and service life of the products. There is ample evidence of this in the papers read before the Rubber Division, the great majority being devoted, directly or indirectly, to *GR–S* processing difficulties.

Six to twelve months ago, the rubber manufacturer's primary anxiety was to masticate, plasticize and render self-adhesive or 'tacky' the *GR–S* mixings from which rubber articles are built or moulded. No entirely satisfactory methods are yet available for this work, but provisional practical processes have been made generally known with which we can 'make do' until better are found. The relief from this anxiety has transferred attention to vulcanization difficulties, of which the variability aspect is the worst. A paper by F. E. Rupert and F. W. Gage reveals that atmospheric humidity is a factor of the first importance in the question. Exposure of unvulcanized mixings to increased humidity and increased length of exposure increases the rate of vulcanization by as much as one hundred per cent. Other evidence has been accumulating for some time, all indicating that very exact control of the water content of *GR–S* mixings is of vital practical importance.

Revolutionary ideas on the acceleration of vulcanization were given in a paper by A. A. Somerville in announcing two new copper compounds as being several times as active as conventional accelerators. So little as 0·01 per cent by weight of ordinary 300-mesh copper powder added to a *GR–S* mix will shorten the vulcanization period by half, and the new copper compounds are even more effective. Moreover, instead of the rapid perishing frequently encountered in natural rubber contaminated with copper, *GR–S* articles containing the copper accelerators actually have increased resistance to ageing. Sixteen other metals failed to show these remarkable effects.

Equally novel was a paper read by G. M. Wolf, T. E. Deger, H. I. Cramer, and C. C. de Hilster, on the successful use of a new class of vulcanizing agents —alkyl phenol sulphides, in particular *p*-tertiary-amylphenol disulphide. These agents are claimed to possess two very important advantages over sulphur in that (1) they impart some tackiness to *GR–S* mixings, and (2) they give products with outstanding resistance to deterioration by heat. The heating up of large tyres in use, which is the most serious of the unsolved production problems, since the only remedy at present is to use up the scanty stocks of natural rubber, may at least be ameliorated by the application of these sulphide vulcanizers. The heat build-up problem was touched upon, also, in a paper by G. M. Massie and A. E. Warner, who report that the use of a non-persistent accelerator, for example, a substituted lead dithiocarbamate, much reduces the tendency of *GR–S* to stiffen due to service heat, especially if diphenyl-ethylenediamine is used in the mixing.

A third paper, by A. R. Lukens, was also associated with the heat-stiffening question. It was pointed out that the trouble arises mainly from the presence in *GR–S* tyres of liberal loadings of very fine particle carbon blacks. Such loadings have become customary since the other reinforcing agents often used in natural rubber—zinc oxide, magnesium carbonate, whiting, for example—fail to confer any improvement in *GR–S*. It has now been shown, however, that mineral pigments such as those noted can be prepared in much more finely divided forms than hitherto, with the result that they considerably reinforce *GR–S*, but do not cause heat build-up. Mixings containing lower proportions of carbon black and these new fillers may well be a great improvement on to-day's practice.

Other papers at the meeting dealt with various standard problems, adding much valuable information without conspicuous novelties. Reference may be made in conclusion to an account by R. A. Emmett of an interesting range of raw materials comprising blends of various butadiene rubbers with plasticized polyvinyl chloride. Both vulcanizable and non-vulcanizable plastics have been developed in this range. They possess the good qualities of both components and provide a much-needed economy in rubber in a wide variety of applications.

# OBITUARY

## Dr. Ida Smedley-MacLean

THE death of Ida Smedley-MacLean on March 2 is a grievous loss to her many friends and has left a blank in her various fields of activity which it will be hard to fill. The British Federation of University Women, which she was largely instrumental in founding, owes much to her for her devoted service and for the breadth of vision she brought to its work. A resolution passed by the fellowship of the International Federation of University Women at a meeting in Washington on May 6 refers to one of the phases of work which she helped to launch and which has grown into a very valuable contribution to original investigation. The resolution reads as follows: "That the Fellowship Awards Committee of the International Federation of University Women records its grief at the grave loss suffered by the International Federation of University Women in the death of Ida Smedley-MacLean who for so many years played a leading part in the establishment and awarding of our International Fellowships, and who in her own work set a high standard in that type of scholarly research which we have tried to foster".

WINIFRED CULLIS.

After graduation at the University of Manchester, Dr. MacLean (then Miss Ida Smedley) worked on certain problems in pure organic chemistry under Prof. H. E. Armstrong, investigating *inter alia* the cause of colour in the dinitrobenzenes. She also acted as demonstrator in chemistry and carried out researches on problems concerning the increase in molecular refractivity of compounds containing a conjugated ethenoid linkage structure. This work resulted in a very interesting communication on the diphenylbutadienes and hexatrienes published in the *Journal of the Chemical Society* of 1908. Shortly after this early work, Miss Smedley was awarded a Beit Memorial Research Fellowship and went to work in the Biochemical Laboratories of the Lister Institute under Arthur Harden, chemist-in-chief. These laboratories had just been constituted by amalgamation of the Laboratories for Pathological Chemistry under J. B. Leathes (later of Toronto and Sheffield), with the Chemical Laboratory under Harden. One must suppose that about this time Miss Smedley developed that intense and lifelong interest in problems of fat metabolism. Study of fat metabolism and fat synthesis had already been actively pursued at the Institute by J. B. Leathes and the school he there established. It was, however, a field in which few then delved. Dr. Hugh MacLean, who later took a great interest in the study of the lipins, arrived at the Institute as one of Harden's assistants about the same time as Miss Smedley, and their marriage took place in 1913.

Dr. Smedley-MacLean perceived early the biochemical significance and importance of fats. Though to-day much is obscure in the biochemistry of fat, her work has made a valuable contribution to our knowledge of the subject, and particularly to those parts of it which deal with the oxidative breakdown of fatty acids *in vitro* and their synthesis by living organisms. Her early investigations in the field led to the deduction of the presence of a decylenic acid in butter fat, a deduction confirmed by isolation at the hands of other workers some years later. In 1912 appeared two papers in the *Biochemical Journal* on a possible mode of synthesis of fatty acid *in vivo*, in collaboration with Eva Lubrzynska. Laboratory experiments on the condensation together of such simple compounds as aldehydes and pyruvic acid led to the isolation of longer carbon chain substances of a fatty nature. The work crystallized itself in the hypothesis that pyruvic acid was a very probable starting point for the synthesis of fatty acid in the body. It is a hypothesis which merits to this day the most serious consideration by students of the subject. Even now we do not know the actual steps by which fatty acids are built up from carbohydrates *in vivo*. Of added interest and significance in this connexion are the later investigations of other workers on the importance of pyruvic acid in carbohydrate transformations.

With the War of 1914–18, Dr. Smedley-MacLean's energies were diverted to other pressing problems. With Dr. Chaim Weitzmann she worked on the problem of producing acetone on the large scale from starch by fermentation, a project which was eminently successful. With the end of the War, and in spite of greatly increased domestic responsibilities, Dr. Smedley-MacLean again threw herself with great energy into the well-loved work, and many important and interesting papers on the mode of synthesis of fat and carbohydrate in yeast appeared at intervals until about 1939. While seeking a possible laboratory model for the study of the biochemical oxidation of fatty acids, she discovered that hydrogen peroxide in the presence of a cupric salt as catalyst is extraordinarily powerful in its oxidizing action on fatty acids. Within a short time the higher fatty acids may be largely broken down to carbon dioxide, a chemical transformation very difficult or impossible to perform in any other way. This field she cultivated with success up to some few weeks before her death.

From about 1935 onwards interest centred on the fat-deficiency disease of rats discovered by Burr and Burr in 1929 (*J. Biol. Chem.*, 82, 345; 1929). At the Lister Institute the physiological aspects were more closely studied in conjunction with Miss Hume and Miss Henderson-Smith, while the biochemical side was left to Dr. Smedley-MacLean and myself. Her delight and fascination with this work never left her. Besides many other interesting and significant points uncovered, the position of linoleic acid as the probable precursor of arachidonic acid and other very highly unsaturated acids was established. The nature of the fatty acids stored under conditions of disease and cure was also investigated. Finally, the structure of arachidonic acid itself (originally discovered by P. Hartley in 1909 in the same laboratories) was put forward as a result of investigation on a very small quantity of material. The suggested structure was fully confirmed by subsequent work with larger quantities in the United States.

Much has been omitted from this brief note, but it is hoped that sufficient has been said to indicate the late Dr. Smedley-MacLean's comprehensive and intense interest in the biochemistry of fat. I worked with her for many years, and I retain the sense and knowledge of her masterly grip of her field. She sought out the facts, made very sure of them and then held to them amid much cross-fire. She saw the significant correlations between her facts very clearly and rarely went beyond. As a teacher and colleague she never failed to inspire, and there must be many like myself who look back on their "Lister" days with intensely happy memories.

LESLIE C. A. NUNN.

# NEWS and VIEWS

## Engineering Science at Oxford: Dr. Alexander Thom

DR. ALEXANDER THOM, who has been appointed to the chair of engineering science in the University of Oxford, graduated in engineering in the University of Glasgow in 1915, and after a varied experience in civil engineering construction both abroad and in Great Britain was engaged in aircraft design in the later years of the War of 1914–18. In 1921 he was appointed lecturer in engineering in the University of Glasgow, and from that time until the beginning of the present War, Dr. Thom was in charge of the subject of aeronautics and also of the specialist courses in civil engineering. This somewhat unusual combination was of considerable value to the teaching in both subjects, and large numbers of engineering students in all branches have benefited in their scientific training from the lectures in aeronautics given by Dr. Thom. His tenure of the post was marked by a large volume of research work in aerodynamics, comprising exhaustive studies of the flow of a fluid past a cylinder, stationary and rotating, employing both a small wind tunnel and, for an experimental investigation of the pattern round a cylinder at low Reynolds numbers, a small channel using water and oil. In the course of his studies he developed an arithmetical method of solution of the equations of flow for both ideal and viscous fluids. The results of his researches, which have throughout been characteristic of the originality of his mind, have been embodied in numerous papers contributed to Reports and Memoranda of the Aeronautical Research Committee, the Royal Society and the scientific and technical Press. Shortly before the outbreak of the present War, he was given leave of absence from his university duties to engage in work at the Royal Aircraft Establishment, Farnborough, and has latterly been in charge of new developments in the Aerodynamics Department.

## Twenty-fifth Anniversary of the Genetical Society

AT its annual meeting on July 21 the Genetical Society completed the twenty-fifth year of its activity. A gathering was called on June 25, 1919, under the chairmanship of William Bateson, at which it was agreed to found the Society, and the first meeting was held on July 12 of that year. The original list comprised eighty-seven members, and the first president was Mr. A. J. (later Lord) Balfour, who held office until 1930. The Society's eighty-two meetings have been mainly devoted to communications on fundamental genetics, including also addresses by such foreign visitors as Drs. T. H. Morgan, H. J. Muller, A. H. Sturtevant, C. B. Bridges, R. Goldschmidt and Ø. Winge. Interest has, however, not been confined to this narrower field, but, as Bateson intended, has also covered plant and animal breeding, human and medical genetics and, of course, cytology and evolutionary theory. Visits have been made on a number of occasions to plant and animal breeding centres and exhibitions, as well as to Kew Gardens, East Malling and Rothamsted Research Stations, the Lister Institute and the Gardens of the Zoological Society. Joint meetings have been held with the Society for Experimental Biology and the Entomological Society, and doubtless this kind of activity will increase in the future as the applications of genetics become more widely appreciated. The Society also sponsored the Seventh International Congress of Genetics held at Edinburgh in 1939.

Before the War, three or four meetings were held annually. This programme was interrupted in the early years of the War; but since 1941 a return has been made to the pre-war arrangement. The present aim is to hold one symposium and one paper-reading meeting during the winter and spring months, and to visit some appropriate research centre in the summer. The present membership numbers 146, of whom twelve are overseas. Dr. C. D. Darlington is now president and Dr. E. B. Ford and Mr. W. J. C. Lawrence are joint secretaries.

## Education of the Pharmacist

AT the British Pharmaceutical Conference held in London on July 11, the chairman, Mr. H. Brindle, gave an address on the "Education of the Pharmacist". He reviewed the present system of pharmaceutical education and commented on the possible effects upon it of the Norwood Report and the Education Bill. The present qualifications in pharmacy include two diplomas granted by the Pharmaceutical Society: that of the chemist and druggist, and that of the pharmaceutical chemist. In addition, several universities have established degrees in pharmacy. All the diplomas and degrees are registerable qualifications for practice. The chemist and druggist diploma is mainly utilized as the qualification for retail practice, but Mr. Brindle hopes that the higher diploma and the degrees will be in greater demand. Retail pharmacy needs its share of the best brains and the most highly trained pharmacists. It offers opportunities certainly comparable in all respects with those of the other branches of the profession, such as hospital, manufacturing and research.

The Pharmaceutical Society in the past has demanded the university entrance standard for its preliminary examination and Mr. Brindle hopes that this will be maintained. The Norwood Report, however, foreshadows certain complications for retail pharmacy because of the recommendation that the general age for entering a university will in future be eighteen plus. This must lead to an alteration in the present system of apprenticeship. He suggested that apprenticeship has largely outlived its usefulness, and if it is to be retained it might with advantage occur after qualification. The university degrees in pharmacy are now well established, and the graduates are proving their value in ever-widening scientific fields. Mr. Brindle hopes that the post-war educational world will provide facilities for brilliant students unhampered by financial handicaps and that university education will be free to all who show themselves capable of benefiting by it.

## Veterinary Practice by Unregistered Persons

IN accordance with the recommendation made by the Loveday Committee on Veterinary Education in Great Britain, the Minister of Agriculture and Fisheries and the Secretary of State for Scotland have appointed a Committee to inquire into the extent and effect of veterinary practice in Great Britain by persons who are not registered veterinary surgeons, and to make recommendations as to any measures which may be desirable to limit or regulate such practice. The Committee is constituted as follows: Sir John Chancellor (*chairman*); Mr. A. C. Brown; Sir Daniel Cabot, chief veterinary officer, Ministry

of Agriculture and Fisheries; Mr. J. W. Salter Chalker, chairman of the Diseases of Animals Committee of the National Farmers' Union; Mr. Charles Dukes, general secretary of the National Union of General and Municipal Workers; Prof. James Gray, professor of zoology in the University of Cambridge and member of the Agricultural Research Council; Mr. C. M. Holmes, vice-president of the Association of Unqualified Practitioners and Animal Castrators; Mr. W. F. Holmes, member of Council of the Kennel Club; Mr. Robert Hobbs, member of Council of the Royal Agricultural Society of England; Mr. W. D. Jackson, past president of the National Farmers' Union and Chamber of Agriculture of Scotland; Sir Louis Kershaw, member of the Loveday Committee on Veterinary Education; Lieut.-Colonel P. J. Simpson, member of Council of the Royal College of Veterinary Surgeons. The Secretary to the Committee is Mr. G. H. Higgs, of the Ministry of Agriculture and Fisheries, to whom communications should be addressed at 99 Gresham Street (First Floor), London, E.C.2.

### Biological Standardization

BIOLOGICAL standardization is the theme of the *Bulletin of the Health Organisation* (VI, **10**, No. 2; 1942–43. Geneva (London: Allen and Unwin, League of Nations Publications Dept. 4*s*.)). The issue contains two articles on the biological standardization of heparin and on a provisional international standard for this substance, and other articles on standard preparations for the assay of the three gas-gangrene antitoxins, on the complexity of the tetanus toxin and on the variable interactions of tetanus toxins and antitoxins. The rest of the issue is occupied by seven articles from the Department of Biological Standards of the National Institute for Medical Research, London. The first of these deals with recent changes relating to international standards for certain sex hormones and for pituitary posterior lobe, due to exhaustion of stocks of the original preparations which had served as international standards for these hormones and the consequent need for their replacement by other samples. The other six articles deal with replacements of the substances of the international standards for the œstrus-producing hormone, for male hormones, progesterone and pituitary posterior lobe and with the international preparation of desiccated ox anterior pituitary gland and the international standard of prolactin.

### Status of Statisticians

THE report of the Committee of the Royal Statistical Society on the Status of Statisticians, appointed by the Council on July 22, 1943 as amended and adopted by the Council, has now been issued. The present position in Great Britain is regarded as unsatisfactory in some respects. First, an employer requiring the services of a statistician on his staff has no common standard among the qualifications which he can accept as a certificate of proficiency, and the report, in confirmation of this point, notes that in recent discussions on the Society's report on official statistics, the Treasury representatives indicated how useful it would be to departments, in considering appointments to responsible positions in statistical branches, if approved statistical qualifications were in existence. The position is also unsatisfactory to an employer, because there are no generally recognized definitions or descriptions of the various types of statistician. It is equally unsatisfactory to the employee, because there is no recognized status in his profession and no generally approved method of distinguishing between a genuinely accomplished man and a mere quack, or even a rank impostor. It is also unsatisfactory to an employee not to have any standards by which he can judge the level of his own attainment, or to which he can work. The situation is unsatisfactory for the general public, which is affected more than it realizes by bad statistical work.

The Committee considers, therefore, that there is a strong case for instituting some method of determining the professional status of statisticians. It believes that the universities must continue to be the main source of training in statistics, and it would welcome any extension of the facilities already provided, although it does not think that the universities can provide adequate tests of proficiency in statistics for all who are likely to require them; also, existing examinations are not sufficient to provide all the requisite professional qualifications. Accordingly the Committee proposes a scheme under which power would be sought by way of a Supplemental Charter to enable the Council of the Royal Statistical Society to confer on approved candidates a diploma in statistics and to issue a certificate to those who pass Part 1 of the examinations. This would provide specifically for those who may be termed statistical computers or junior statisticians. Candidates for the certificate or diploma should not be limited to fellows of the Society, and those for the diploma should be required to pass Parts 1 and 2 of the prescribed examinations, a suggested syllabus for which is appended to the report, and also to show that they had had satisfactory experience of statistical work over a period of not less than two years. A candidate for the certificate or diploma should be exempted from the whole or any section or sections of the examinations if he has passed examinations approved by the Council. While so far as concerns the scientific aspects of the Society's work, no change is suggested in the present system of election of fellows, in the qualifications required, or in their title, status and privileges, additional by-laws would be required to regulate the award of the certificate and the diploma.

### Astronomy in the U.S.S.R.

POST-WAR astronomical research in the Soviet Union is being planned on a great scale. Nine of the nineteen Soviet observatories were in territory that was overrun by the Germans and have been destroyed or seriously damaged. Most important of these was the Pulkovo Observatory, near Leningrad, which was completely destroyed by air and artillery bombardment. Most of the equipment and the valuable library of the Observatory were removed in time to safer places. The Pulkovo staff has continued astronomical research work at Tashkent, Abastumani and Alma-Ata. Prof. Belyavsky, director of the Observatory, states that it has been decided that reconstruction is to commence immediately and that the instrumental equipment will be reinstalled at Pulkovo at the earliest possible moment, to make possible the resumption of work in fundamental astronomy. More powerful equipment is to be constructed in the U.S.S.R. or obtained from abroad. The Engelhardt, Nikolaeff and Tashkent Observatories will also carry on fundamental observations.

The *Moscow News* has reported the decisions of

an astronomical conference held in Moscow in September last. A great astrophysical observatory is to be established with headquarters at Simferopol in the Crimea. There will be three observing stations, one in the Crimea at an altitude of 2,000 metres, a solar station at an altitude of 3,500 metres, and a station somewhere in the southern hemisphere. The equipment will include a 120-in. reflector, two 80-in. reflectors, two 16-in. double astrographs, one 50-in. and one 30-in. Schmidt telescope, solar towers and a coronagraph. The training of astronomical staff has continued during the War; some sixty or seventy astronomers and astrophysicists will be required for staffing the new institution. Information has been received that the international latitude station maintained by the U.S.S.R. at Kitab, Uzbekistan, has continued to function regularly throughout the War.

### Library Service in South Africa

IN his presidential address to Section F of the South African Association for the Advancement of Science delivered on June 29, 1943, on "Libraries and Science" (*South African J. Sci.*, 40, 81; November 1943), P. Freer referred particularly to the difficulties of book selection in scientific literature. He urged that this is not a matter for librarians alone, and that librarians should also do more to secure the writing and publishing of authoritative but simple and readable books on important subjects. After pleading for more care and co-operation in the discarding of surplus or unwanted stock, Mr. Freer indicates measures that are required for the full efficiency of the inter-library loan system. Until the master-catalogue of non-fiction in the libraries of the Union of South Africa is completed, as well as the publication of a new edition of the Lloyd's List of Scientific and Technical Periodicals, with a complementary volume covering the humanities, book-buying and discarding are both unscientific. As regards the imperfections and limitations of present abstracting and indexing services for scientific and technical periodicals, Mr. Freer notes that only forty-one of the three hundred abstracting and indexing periodicals in existence in 1937 were available somewhere in South Africa, and these periodicals only covered one third of the scientific papers concerned. He emphasized the need, for the advancement of science, of a highly trained staff and augmented resources to diminish the gap between the 6,000 titles in the Catalogue of Union Periodicals and the 15,000 acknowledged as being of international importance. Plans for post-war reconstruction contained no suggestions for a national library system, but in addition to national libraries, regional libraries and organization would be required. Finally, he referred to the contribution which science could make to the improvement of the printed book itself and its preservation.

### Mexican Institute of Nutrition

ACCORDING to an annotation in the September issue of the *Boletín de la Oficina Sanitaria Panamericana*, the newly organized Institute of Nutrition in Mexico includes the following sections: bromatology, economic, social and dietetic departments, clinical medicine and a clinical laboratory, and maternal and child welfare. In the near future, the bromatology section will undertake studies of the chemical composition of legumes and maize, and the economic section will undertake an investigation of the state of nutrition of about seven hundred families in an area of Mexico City. The clinical laboratory will determine the vitamin content and blood count of the families studied. The maternal and child welfare division has already started work on the vitamin content of the blood of pregnant women at different periods of pregnancy, and a training centre has made plans for courses for the selection of dietitians and experts in nutrition.

### An Automatic Vibration Analyser

ONE of the potential causes of failures in an aeroplane power-plant or the aeroplane structure itself is excessive vibration. While every effort is made to reduce the number of modes of vibration which might be excited to objectionable amplitudes, it is desirable to measure the power-plant and aeroplane vibration characteristics in flight to ensure that there are no vibrations of sufficient magnitude to cause fatigue failures in any parts. In the Bell Laboratories an automatically tuned wave analyser has been developed to meet the needs of the Pratt and Whitney Aircraft Division of United Aircraft Corporation, which desired apparatus that when used in conjunction with suitable vibration pickups would measure the amplitude of vibration at a frequency equal to any predetermined multiple of engine revolution per minute, even when the engine speed is continuously changed. This analyser can be used with a recorder to draw curves of the amplitude of vibration of selected orders of frequency as a function of engine speed. An article by F. G. Marble (*Bell Lab. Rec.*, 22, No. 8; April 1944) describes the analyser and its use.

### Illuminating Engineering Society

DURING the past few years the membership of the Illuminating Engineering Society has approximately doubled, it has formed new centres and groups throughout Great Britain, and its activities have greatly increased. In addition, it has in prospect a programme of still greater activity and of new developments in the post-war period. In order to cope with these developments the Council is now contemplating the appointment of a full-time paid secretary who, it is hoped, will eventually take full charge of its administration. In the meantime, however, the Council hopes to continue to benefit for some time to come from the services of its honorary secretary, Mr. J. S. Dow, who has been associated with the Society since its inception in 1909.

### Institution of Electrical Engineers: Radio Section

ON the recommendation of the Wireless Section Committee the Council of the Institution of Electrical Engineers has decided to change the name of the Section to "Radio Section" and to modify Rule No. 1, which deals with the scope of the Section, to read as follows: "The Section shall include within its scope all matters relating to the study, design, manufacture or operation of apparatus for communication by wave radiation, for high-frequency and electronic engineering, or for the electrical recording or electrical reproduction of sound".

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ERRATA.—In the communication "Physico-Chemical Properties of the Surface of Growing Plant Cells" by Prof. H. Lundegårdh and G. Stenlid in *Nature* of May 20, p. 618, Fig. 1 and Fig. 2 should be interchanged. The absorption maximum of the flavonone is in two places in the text erroneously assigned to 2550 A. instead of 2850 A.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## A Notation for Organic Compounds

DR. A. R. RICHARDS[1] proposes a form of 'chemical shorthand' to designate the commoner hydrocarbons and their simple compounds. This he claims may avoid the practice of coining names such as 'triptane' for '2,3,3-trimethylbutane'; in practice it will not have this effect. Once a substance leaves the laboratory and enters the plant, it *must* have a short distinctive title by which all and sundry can refer to it; and in 'triptane' such a word has been found. What we must most sedulously avoid is the unwarrantable intrusion of such coined names into systematic nomenclature. G. C. Foster, so far back as 1865[2], pointed out that all sciences have two distinct requirements of nomenclature—a convenient *general* language and a systematic or 'legal' language. The former serves for the ordinary everyday transactions of science and manufacture and will, "in the main, take care of itself; and at any given period it usually contains a large admixture of terms—once technical, but now no longer used for purposes of accuracy—which, like fossils in a rock, tell of the successive changes by which the existing state of things has been brought about". The strictly legal or premeditated language of organic chemistry is for cataloguing and identifying substances with absolute precision and expedition.

At present we have a choice in the exact delineation of an organic structure between an ideograph (the structural formula) and a so-called 'systematic' name. The ideograph is space-consuming, has no sound equivalent and cannot be indexed in list form, since a series of structural formulæ has no intrinsic basis of ordered arrangement; on the other hand, it is immediately intelligible to the eye and easily remembered. 'Systematic' names are cumbrous, often ambiguous, very long to print, and have never attained more than a measure of popularity with practical chemists. They impose an intolerable burden on the memory, being related to a large group of 'trivially' named nuclei, many of which are virtually unknown. Further, they are often unpronounceable owing to the use of various types of brackets, subscripts, dashes and the like which not only complicate printing but also have no simple vocal equivalent [for example, pronounce the following: Spiro [3-naphtho [1,2] triazole-2,2′-3′-ox-2′azatricyclo [3.3.3]. nona-1′(8′),5′(9′)6′-triene] and then jot down its structure (Ring Index No. 3179)].

Most chemists actually remember the structure or ideograph and associate the idea of a name; after a time many structures and names become so closely associated as to be almost indissoluble in the memory; but such are only a small fraction of those ordinarily used, while the rules and exceptions of systematic nomenclature are tedious both to learn and to apply.

Ordinary systematic nomenclature has failed to give that degree of precision and ease of reference required by modern developments of the science, and I have developed during the past few years a system of ciphering for organic compounds which provides a method of reference and classification capable of providing a unique cipher for every structure. Such ciphers have a logical system of enumeration, use only the capital letters, θ, and the Arabic numerals, without subscripts, brackets or dashes and are, moreover, capable of being 'interpreted' on a punched card system; the 'sorting' of cards into categories can be readily accomplished and a form of mechanical indexing and reference is thus achieved. In addition, the machine can automatically compute, from the card, the empirical formula of the compound.

Space does not permit the discussion of details of this system, which will be published elsewhere shortly, but my purpose in writing will be served if attention is directed to (*a*) the inevitability of short or trivial names for substances in common use; (*b*) the undesirability of allowing such names further to complicate our systematic nomenclature; (*c*) the desirability of any universally adopted cipher system being complete, international and mathematically adaptable.

G. MALCOLM DYSON.

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Genatosan, Ltd.,
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June 24.

[1] *Nature*, 153, 715 (1944).
[2] *Phil. Mag.*, 29 (April 1865).

## A Silicified Member of the Cyclanthaceæ from the Tertiary of the Deccan

NEW discoveries of fossil plants, while frequently solving problems of geographical distribution, often throw up fresh problems that baffle solution. Recent work on the silicified flora of the Deccan Intertrappean Series (which with all deference to the 'official' view of the Geological Survey of India we regard as Early Tertiary and not Late Cretaceous[1]) has brought to light genera which are either identical or very closely related to living types now confined to parts of South America. A year ago, one of us reported the occurrence in these beds of well-preserved silicified sporocarps essentially of the Regnellidium type, which he referred to a new genus, Rodeites[2], closely allied to the Brazilian water-fern *R. diphyllum*. We now record the occurrence in the same locality (Mohgaon Kalan, in the Central Provinces) of a new silicified member of the Cyclanthaceæ, a family now living only in tropical America. Of this family we had hitherto no definite fossil record. The leaf-impressions from the Eocene of Sézanne, which Saporta[3] referred to a new genus, Ludoviopsis, may equally probably belong to palms.

We recently suggested[4] that the silicified stem from the Deccan, described by K. P. Rode in 1933 under the name *Palmoxylon Sahnii*[5], is probably not a true palm but an extinct member of the Cyclanthaceæ. A detailed anatomical examination of the vegetative organs of this plant, of which two large specimens were found by one of us at the same locality in 1941, has now proved that our surmise was correct. In its main anatomical features the fossil shows a close resemblance to Cyclanthus. Thus the root structure is very similar to that of the modern genus; in both forms the pith is fibrous and there are ten or more protoxylem groups. The fibrovascular bundles of the stem, which Rode described in some detail, also resemble those of Cyclanthus in the crescentic arrangement of the xylem vessels and in the peculiar compound (? branched) nature of the bundles. As in Cyclanthus, too, the leaf sheaths contain a row of large secretory canals.

The flowers and fruit of the fossil are unknown, hence the exact affinities are still rather obscure. But the anatomical resemblances with Cyclanthus are set off by the arboreous habit of the plant which, as stated last year, "must have grown rooted in shallow water, with the stems rising in a clump, somewhat like those of a bamboo"[4]. These differences, coupled with the distance in time and space which separates the living and the extinct forms, suggests that the fossil should at least provisionally be referred to a new genus of the sub-family Cyclantheæ.

The generic name Cyclanthodendron is proposed. This new genus provides (like Rodeites) another interesting link between the Early Tertiary flora of the Deccan and the modern flora of South America.

B. SAHNI.
K. R. SURANGE.

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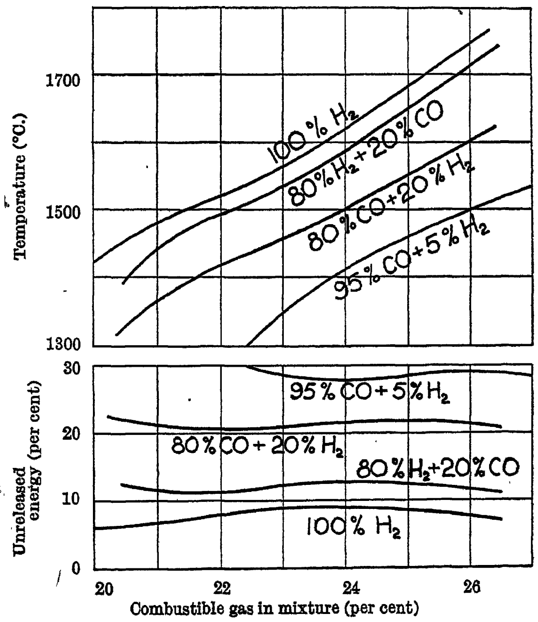
University of Lucknow.
April 19.

[1] Sahni, B., *Curr. Sci.*, **3**, 134 (1934). *Proc. 24th Ind. Sci. Cong.*, 464 (1937). *Lucknow Univ. Studies*, 2, 59 (1938). *27th Ind. Sci. Cong.*, Pres. Add. (1940).
[2] Sahni, B., *J. Ind. Bot. Soc.*, **22** (2, 3, 4), 180, pl. 9, fig. 42 (1943).
[3] Saporta, *Mém. Soc. Géol. France*, **3**, 333, pl. IV, figs. 1, 3 (1868).
[4] Sahni, B., and Surange, *Abs. Proc. Ind. Acad. Sci.*, and *Nat. Acad. Sci. Hyderabad*, 24 (1943).
[5] Rode, K. P., *Quart. J. Geo. Min. and Met. Soc. India*, 5 (3), 111 (1933).

## Unreleased Energy in Flame Gases

WE recently reported[1] the results of temperature measurements made by means of very fine quartz-coated platinum wires in the flame gases resulting from the combustion of hydrocarbon-air mixtures in a specially constructed burner. From these measurements estimates were made of the proportion of the heat of combustion which was unreleased in the flame gases for the purpose of increasing their temperature. The unreleased energy, we believe, is due partly to latent energy held in stable form in some of the newly formed tri-atomic molecules and partly to abnormal dissociation resulting therefrom. It varied from about 10 per cent to rather more than 20 per cent of the heat of combustion.




Similar measurements have since been made using mixtures of air with hydrogen and with carbon monoxide plus hydrogen in various proportions. The curves in the top portion of the accompanying graph show these measurements. It will be seen that for any given mixture strength the hydrogen flame gas temperature is more than 200° C. higher than the carbon monoxide (with 5 per cent hydrogen) flame gas temperature—and this in spite of the fact that the calculated hydrogen flame gas temperatures are more than 100° C. lower than the calculated carbon monoxide flame gas temperatures. The measured temperatures have not been corrected for radiation loss, but even after making full allowance for this, the hydrogen temperatures are of the order of 150° C. below and the carbon monoxide (with 5 per cent hydrogen) temperatures of the order of 500° C. below the corresponding calculated temperatures.

Curves giving estimates of the unreleased energy are shown in the lower portion of the graph. In the hydrogen flame gases this is of the order of 8 per cent of the heat of combustion and in the carbon monoxide (with 5 per cent hydrogen) flame gases it is nearly 30 per cent. There is little doubt that in flame gases resulting from the combustion of carbon monoxide with a much smaller proportion of hydrogen it would be considerably greater than 30 per cent.

W. T. DAVID.
J. MANN.

Engineering Department,
The University,
Leeds.
June 9.

[1] *Phil. Mag.*, **34**, 816 (1943).

## Rayleigh Quenching of Active Nitrogen

ARISING out of work[1] on the disappearance of the nitrogen afterglow by heating the activated gas at various pressures, it may be of interest to record results which indicate limits for the production of a like phenomenon observed by Lord Rayleigh[2], namely, the quenching of the afterglow due to cooling by liquid air. With a condensed discharge in a Crookes' tube connected in series with a long glass spiral $S$, and a small bulb containing powdered iodine, the activated gas excited the characteristic iodine luminescence even when the afterglow in the observation spiral $S$ was feeble; both disappeared when $S$ was cooled by liquid air, in agreement with Rayleigh's observation[2]. That this phenomenon is, however, restricted to low pressures is shown by the fact that when the gas pressure was increased progressively from 0·1 mm. the Rayleigh quenching in $S$ tended to be less marked; was uncertain near 30 mm. and not observed above 40 mm.

A possibly insufficient cooling of the activated gas at high pressures was minimized as follows. The nitrogen was first streamed through a long spiral of glass, which enclosed the Crookes' tube; while both these were well immersed in a bath of liquid air, the gas was subjected to the discharge. A distinct afterglow was produced in $S$ even when it was cooled by liquid air, and was accompanied by luminescence in the iodine bulb. Both these effects were observed also at smaller pressures, at which under normal conditions (that is, when not cooled by liquid air before and during activation by the discharge) the Rayleigh quenching occurred. Addition of one more spiral cooled by liquid air, just before the one

surrounding the discharge tube, making the total cooling path about three yards in length, had little effect on the results. A high gas pressure and low temperature activation, therefore, are unfavourable to the occurrence of the Rayleigh quenching.

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[1] Joshi and Purshotham, *Proc. Ind. Acad. Sci.*, **19**, No. 4 (1944).
[2] Strutt, R. J., *Proc. Phys. Soc.*, **23**, 66 (1910); *Proc. Roy. Soc.*, A, **85**, 219 (1911). Trowbridge, *Phys. Rev.*, **23**, 279 (1906).

## Constitution of some Binary Oxide Systems

THE constitution of the oxide systems FeO–MnO, FeO–MgO, CaO–MnO and MgO–MnO have been studied by the X-ray diffraction method. Preparation of the powder samples was carried out *in vacuo* at temperatures up to 1350° C., followed by slow cooling to 1150° C., from which temperature the samples were rapidly cooled.

The X-ray patterns showed that the four systems are single phase. It was possible to make accurate lattice dimension measurements for all samples. The result on the FeO–MnO system is in agreement with that of Andrew, Maddocks and Howat[1] and of McCaughey[2], but in contradiction to that of Benedicks and Löfquist[3] and Hay, Howat and White[4]. The FeO–MgO system has been reported to be a single phase system by Bowen and Schairer[5], following the use of thermal and optical methods. References have not been found to any previous work on the CaO–MnO and MgO–MnO systems.

Full details of the work will be published later.

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[1] Andrew, Maddocks and Howat, *J. Iron and Steel Inst.*, **2**, 283 (1931).
[2] McCaughey, Amer. Open-Hearth Proc. 1938, Discussion, p. 169.
[3] Benedicks and Löfquist, "Non-Metallic Inclusions in Iron and Steel" (1930).
[4] Hay, Howat and White, *J. West Scot. Iron and Steel Inst.*, **41**, 97 (1933–34).
[5] Bowen and Schairer, *Amer. J. Sci.*, **29**, 151 (1935).

## A Molecule-building Principle

IT has long been realized in the field of molecular spectra that there is need of some form of molecule-building principle equivalent to the *Atombau* principle of Bohr. This would enable the electron configuration and term type of at least the ground-state of any molecule to be predicted from its position in the Periodic Table. Mulliken[1] attempted to trace the change in electron configuration from molecule to molecule for the lighter members of the Table, but his pioneering work was hampered by the absence of many necessary spectrum data, and no progress has since been made. In particular, very little knowledge has been obtained on the configuration of the heavier diatomic molecules.

I have been studying for some time the spectra of the heavy fluorides of the series, AuF, HgF, TlF, PbF and BiF, and it is now possible to describe their ground-states in terms of electron configurations. These are shown in Table 1, along with the corresponding iso-electronic oxides and their probable configurations.

TABLE 1.

| Molecule | AuF | HgF | TlF | PbF | BiF |
|---|---|---|---|---|---|
| Type | $^1\Sigma$ | $^2\Sigma$ | $^1\Sigma$ | $^2\Pi$ | $^3\Sigma$ |
| Config. | $\pi^4$ | $\pi^4\sigma$ | $\pi^4\sigma^2$ | $\pi^4\sigma^2\pi$ | $\pi^4\sigma^2\pi^2$ |
| Molecule | AuO | HgO | TlO | PbO | BiO |
| Type | $^2\Pi_i$(?) | $^1\Sigma$ | $^2\Sigma$ | $^1\Sigma$ | $^2\Pi$ |
| Config. | $\pi^3$ | $\pi^4$ | $\pi^4\sigma$ | $\pi^4\sigma^2$ | $\pi^4\sigma^2\pi$ |

Iso-electronic molecules connected by dotted line.

It is evident that a building principle is operating in which the configuration of a given molecule retains the structure of the preceding with the addition of an electron to the lowest available orbital.

It is of interest to note the probable configuration and term type of the molecules AuO (AgO and CuO) and BiO, the spectra of which are still in a state of confusion. More information can be derived for the $^2\Pi$ BiO state by examining the doublet separations of the $^2\Pi$ states arising from $\pi^4\sigma^2\pi$, given in Table 2.

TABLE 2.

| CF | NO | SiF | PO | GeF | AsO | SnF | SbO | PbF | BiO |
|---|---|---|---|---|---|---|---|---|---|
| (60) | 121 | 161 | 221 | (920) | 1027 | 2317 | 2272 | 8260 | |

Bracketed values are predicted in forthcoming publication.

This suggests that an electronic interval of the order of 8,000 cm.$^{-1}$ should be sought for among the many bands of this molecule.

A fuller report of this work will be published elsewhere.

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[1] *Rev. Mod. Phys.*, **4**, 1 (1932).

## *Torulopsis utilis* and the Citric Acid Cycle

THE ordinary strain of *Torulopsis utilis* (Henneberg) deriving from Haehn[1] can easily grow on a great many substrates under aerobic conditions (cf. Fink[2]). Nevertheless, there are still many substrates to which the Torulopsis yeast can be accustomed. Among others, I have studied some of the acids belonging to the so-called citric acid cycle of Krebs[3].

In my experiments the standard Torulopsis yeast was cultivated on ethyl alcohol, ammonia and salts, including the sulphates and phosphates of potassium, magnesium and calcium. These salts being of technical quality, it is probable that they contained other elements necessary for the growth of the yeast, for example, iron.

Cultivations were carried out under vigorous aeration. The substrate, except in the earliest stages of adaptation to a new substrate, was added in small portions, using a time schedule, so that the concentration of substrate might be as small as possible.

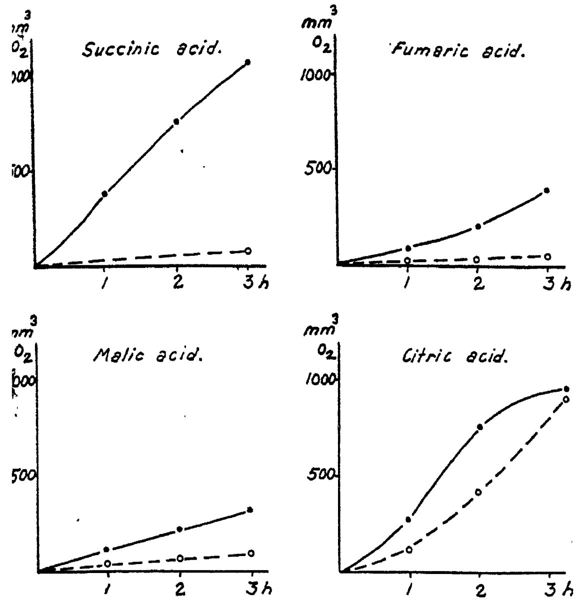


Fig. 1. UPTAKE OF OXYGEN BY *Torulopsis utilis* IN THE PRESENCE OF VARIOUS ACIDS. THE YEAST WAS ADAPTED TO SUCCINIC ACID. EACH WARBURG CUP CONTAINED 20 MGM. OF FRESH YEAST, 1 ML. 0·2 $M$ $KH_2PO_4$, 0·3 ML. 0·1 $M$ ACID, NEUTRALIZED TO $p$H 4·5 AND WATER TO 2·4 ML. THE EXPERIMENTS REPRESENTED BY THE BROKEN LINES CONTAINED ALSO 0·2 ML. 0·1 $M$ MALONIC ACID.

It was found that the standard yeast grown on ethyl alcohol could not initially use succinic acid but that it could be adapted rather easily to that substrate in the presence of ammonia and salts. It was much more difficult to adapt the yeast to malic, fumaric or citric acid, which also were not attacked initially. The yeast cultivated on succinic acid did not at first show any noteworthy new properties as detectable by adding the acids just mentioned to a suspension of yeast and determining the oxygen uptake in the Warburg apparatus. By cultivating the yeast twice more on succinic acid using the same technique, it was found, however, that the yeast had changed. It was now able to attack all four of the acids just mentioned, but not maleic, *trans*-aconitic or malonic acid. Moreover, on adding malonic acid and one of the acids succinic, malic, fumaric or citric simultaneously, it was found that the oxygen uptake was to a great extent inhibited, which had not formerly been the case (Fig. 1).

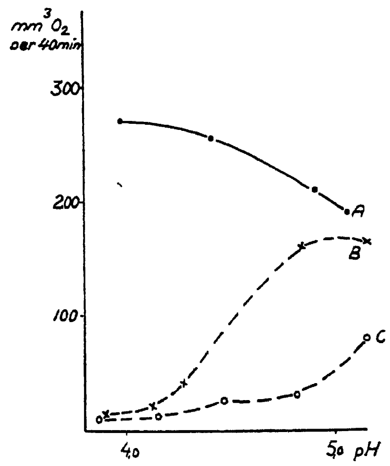


Fig. 2. UPTAKE OF OXYGEN DURING THE FIRST 40 MIN. OF THE EXPERIMENT BY THE SAME YEAST AS FIG. 1. EACH CUP CONTAINED YEAST, $KH_2PO_4$ AND WATER AS BEFORE AND 0·3 ML. 0·1 $M$ SUCCINIC ACID. $B$ ALSO CONTAINED 0·1 ML. AND $C$ 0·2 ML. 0·1 $M$ MALONIC ACID.

To ensure that the *Torulopsis utilis* had not been contaminated with any other kind of yeast, samples were spread on agar plates and found to be identical with the original yeast and very pure.

The activity of the Torulopsis yeast towards succinic acid (and towards the other acids) is very dependent on the $p$H of the suspension, being greater at acid $p$H (Fig. 2).

The property of the yeast of being able to attack succinic acid, etc., had not altered its behaviour towards other substrates such as pyruvic, lactic or acetic acid or ethyl alcohol or glucose, nor did malonic acid inhibit the breakdown of any of them. The inhibition brought about by malonic acid in the case of citric acid is merely a period of induction which lasts about one hour.

The observations described above suggest that although the enzymes of the citric acid cycle are possibly not normal constituents of the Torulopsis yeast, they can be synthesized under the conditions given. It seems justifiable to suppose that a particular enzyme effecting the breakdown of succinic acid is built up during adaptation. The action of this enzyme can be inhibited by malonic acid. The citric acid cycle does not seem to play any considerable part in the breakdown of pyruvic acid in this yeast.

Experiments have also been made to cultivate the yeast, adapted to succinic acid, on citric acid. The yeast grew well though not so fast as on, for example, ethyl alcohol or glucose. All the carbon of the substrate could be accounted for as yeast substance and carbon dioxide, indicating that no intermediates had been accumulated.

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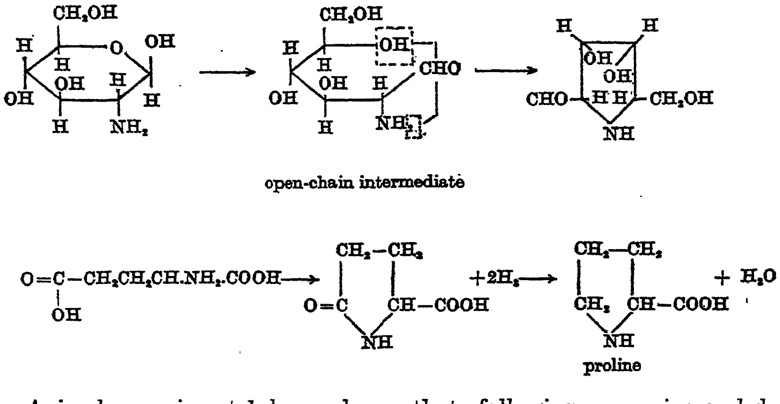
[1] Lodder, J., *Verhand. Kon. Akad. Wet.*, Amsterdam, Sect. II, **32**, 1 (1934).
[2] Fink, H., and Krebs, J., *Biochem. Z.*, **300**, 59 (1938).
[3] Krebs, H., and Johnson, S. W., *Enzymologia*, **4**, 148 (1937).

## Porphyrin Metabolism in Idiopathic Porphyria

IDIOPATHIC porphyria is especially interesting as the urinary pigment uroporphyrin III associated with this disease resembles closely in its chemical structure the protoporphyrin of hæmoglobin. Urinary uroporphyrin may provide here an index of the rate of protoporphyrin formation in the body, and it seemed important to obtain information on this point, and to observe if uroporphyrin III excretion is augmented by administration of substances which, on a theoretical basis at least, could function as protoporphyrin precursors.

With the excellent co-operation of a porphyric of mild, chronic type, investigations were made on the effect of administration of *d*-glucosamine on porphyrin excretion. It was considered that 2-amino-sugars such as 2-amino glucose or 2-amino arabinose might condense *in vivo* to form pyrrole and porphyrin derivatives which would be excreted. 2-amino glucose may be represented as a possible source of a simple pyrrolidine derivative, following a reaction

similar to the internal condensation of glutamic acid to form the lactam, pyrrolidone carboxylic acid, which by reduction yields pyrrolidine carboxylic acid, or proline.




Animal experiments[1] have shown that, following administration of *d*-glucosamine hydrochloride, the amino sugar is collected to a relatively large extent by the liver and kidney, where it is slowly decomposed. Kawabe[1] found that incubation with liver tissue *in vitro* for 7 hours caused the decomposition of 28 per cent of added *d*-glucosamine hydrochloride.

Accordingly, a control experiment on myself with 20 gm. *d*-glucosamine hydrochloride having produced no ill-effects, 20, 30 and 40 gm. were given by mouth on three consecutive days, the hæmoglobin value being 90 per cent. No increase of uroporphyrin was observed either immediately or during the succeeding two months, but large quantities of a reddish-brown, green fluorescent pigment appeared in the urine. This pigment was soluble in ether and chloroform, exhibited urobilin-like absorption at 520 mμ, but after reduction with ferrous hydroxide or sodium amalgam failed to give a colour with Ehrlich's aldehyde reagent. It was therefore neither urobilin nor the porphobilin of Waldenström and Vahlquist[2].

That this pigment was not produced by acid treatment of *d*-glucosamine in the urine was proved by addition of amino sugar to normal and porphyric urines, which were then subjected to the same isolation procedure. Pigments so obtained showed no fluorescence.

Two months after the above experiment, the circulating hæmoglobin level had fallen to 50 per cent, with red blood cells numbering 2,070,000 and colour index 1·16. To improve this condition a concentrated liver extract containing iron was given by mouth over a period of seven days (30 ml. per day), when it had to be discontinued. The effect of this treatment was extremely adverse, as it was followed immediately by an attack of migraine, vomiting, sleeplessness and severe constipation lasting three weeks, during which the urinary uroporphyrin excretion reached a peak value of 26·7 mgm. per litre.

There was no evidence of increased blood destruction as indicated by urobilinogen output, and it was concluded that the raised uroporphyrin excretion was associated at that time with increased rate of erythropoiesis and porphyrin synthesis.

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[1] Kawabe, K., *J. Biochem.*, **20**, 243 (1934).

[2] Waldenström, J. and Vahlquist, B., *Z. Physiol. Chem.*, **260**, 189 (1939).

## Bacteria Responsible for the Loosening of Wool on Sheepskins

THE sweating process of fellmongering is widely used in Australia, especially for treating merino sheepskins. It depends on the natural loosening of the wool that occurs when the skins are exposed to the air and kept moist for some days. The wool can then be easily removed by 'pulling'.

Investigations of the sweating process in this laboratory[1] have been greatly facilitated by the development of two new experimental methods:

(1) A physical method of following the progress of wool loosening. This involves measurement of the pull in grams weight to remove a staple of wool of which a 2·5 cm. length after scouring and drying weighs 1 mgm. The staples are pulled manually by means of a clip attached to a 250-gm. spring balance, and the average of six values determined for any particular sample of skin is referred to as the 'depilation load'. The depilation load must be practically zero before the wool can be pulled easily.

(2) A method of sterilizing sheepskin and removing the sterilizing agent to permit investigation of the wool-loosening activity of pure cultures of bacteria. The skin sample is immersed for 17 hr. in 0·05 *M* sodium metabisulphite adjusted to *p*H 2, the residual sulphurous acid and its salts are oxidized by immersion for 7 hr. in 0·3 *M* hydrogen peroxide, and the *p*H value at the skin surface is increased to approximately 8 by immersion for 17 hr. in 0·1 *M* sodium bicarbonate. No visible skin changes are produced in the course of this treatment and only a slight normal fall in depilation load was observed during subsequent storage for three days at 25° C. However, rapid wool-loosening occurred after inoculation of the skin with washings from a non-sterile skin or with some pure cultures of the bacteria listed below. This method was only adopted after it had been shown that the acetone-benzol drying and heating method of Chambard and Azémar[2], X-ray irradiation, and treatment with antiseptics such as chlorine, iodine and mercuric chloride were unsatisfactory owing to the production of undesirable changes in the skin tissues, tendering of the wool, or difficulty of removing the sterilizing agent.

By sterilizing sheepskin as described above and measuring the depilation load during incubation at 25° C. after inoculation with pure cultures of bacteria, it was shown that of the seventy-five species and strains of bacteria occurring on sheepskins, comprising forty-seven aerobes and twenty-eight anaerobes, only four were capable of reducing the depilation load to zero within 41 hr. So far as could be ascertained from Bergey's classification[3], they are: (1) An atypical strain of *Proteus vulgaris* (No. 7). (2) An unidentified species of Achromobacter (No. 42). (3) *Flavobacterium estero-aromaticum* (No. 52). (4) An unidentified species of Flavobacterium (No. 28). (The numbers in brackets refer to the system of classification used in this laboratory.)

Confirmation that only four out of the seventy-five species and strains isolated possess wool-loosening activity was obtained by inoculating sterile fœtal lambskin instead of sterilized adult sheepskin. The skin samples used were removed aseptically

from almost full-term fœtuses, as described by Ellis[4].

Observations on the normal bacterial flora of wool roots during sweating have shown that *Proteus vulgaris* (No. 7) is probably the principal sweating bacterium, for although it occurs in relatively small numbers on the wool at the beginning of sweating, it is present in almost pure culture on the wool roots when wool loosening is complete. Sometimes the unidentified species of Achromobacter (No. 42) is also present at the completion of sweating, but then usually in equal numbers with No. 7. The flavobacteria occur rarely on wool roots during natural sweating.

*Proteus vulgaris* (No. 7) may be identical with *Bacillus pilline* isolated from sheepskins by Villon[5], and with the Streptococcus of Schmitz-Dumont[6], since its morphology varies under certain conditions. Similarly the bacilli "d" and "e" described by Wood[7], and "No. 1" and "No. 6" described by Chambard and Azémar[2], may be identical with No. 7 and No. 42 respectively isolated from Australian sheepskins. Owing to the incomplete descriptions, they cannot be identified with certainty.

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[1] To be described in detail in *Bull. Coun. Sci. Ind. Res.* (Aust.).
[2] Chambard, P., and Azémar, J., *J. Int. Soc. Leath. Trades Chem.*, **16**, 27 (1932).
[3] Bergey, D. H., "Manual of Determinative Bacteriology" (Baillière, Tindall and Cox, London, 1939).
[4] Ellis, W. J., *J. Coun. Sci. Ind. Res.* (Aust.), **16**, 173 (1943).
[5] Villon (1894), cited by Chambard and Azémar (see ref. 2).
[6] Schmitz-Dumont (1897), cited by Chambard and Azémar (see ref. 2).
[7] Wood, J. T., *J. Soc. Chem. Ind.*, **18**, 990 (1899).

## Display and Bower-building in Bower Birds

THE recent note on this subject by Marshall[1] is of considerable interest in directing attention to the life-history of a remarkable group of birds. Of particular significance is the apparent correlation between the colours of the objects used by the male for decorating the bower and the more conspicuous colours of the female. If this correlation exists, it can have obvious epigamic value. Marshall studied especially the satin bower bird (*Ptilinorhynchus violaceus* (Viellot)), which prefers blue and green-yellow objects for decoration, and these colours can admittedly be correlated with the blue eyes of the female and the green-yellow of her plumage. But the spotted bower bird, a speckled brown bird with a bright mauve-red neck-tuft, shows preference for green and white objects, the white objects often consisting of bleached bones. Sometimes, with this species, green berries which have been placed in the bower turn red or yellow and are then promptly rejected. Yet another species, Newton's bower bird, with brown and yellow plumage, collects white flowers only. From the facts so far known, therefore, the correlation between choice of colours and plumage does not apparently extend to other Australian bower birds.

The oil-droplets in the cones of the avian retina form inter-occular filters the colours of which vary with the colour and proportion of the oily constituents, and hence there is reason for believing that the spectral sensitivity of birds will vary from species to species. In other words, we are led by physiological reasoning to suspect specificity in relation to colour-awareness in birds, and from this it is a temptation to assume that such specificity must necessarily bear a relation to the plumage colours of the species. So far, however, few convincing experimental findings have been produced to support this view, and the bower birds, representing as they do a *natural* experiment, will amply repay further close and accurate study, the results of which will far outweigh in value any artificial studies on domestic types like the hen and pigeon.

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[1] *Nature*, **153**, 685 (1944).

## 'Soil' Mechanics

HAVING read with interest the correspondence in recent issues of *Nature* on the suitability of the expression 'soil' mechanics, I am moved to express the hope that the writers will be more successful than I have been in securing the adoption of a better term.

I remember that the use of the expression 'soil' mechanics dates from an earlier time than that of the First International Congress at Harvard in 1935 (as stated by one correspondent) and that I then made strong representations to friends in the United States about its misleading nature. In reply, I was told that it was already too late to effect a change. Then came the Congress, which served to make the term more widely known and established. Thus it appears that, because somebody had mistranslated Terzaghi's original German expression, we were to be condemned for all time to suffer an inevitable muddle in nomenclature.

When, in 1940, I served as the geological member of the appropriate panel of the Committee on Earth Pressures of the Institution of Civil Engineers, I again protested vigorously against this use, or misuse, of the word 'soil', and suggested in its place 'earth', if the alternative and more precise expression 'unconsolidated rocks' (not 'unconsolidated deposits', which is too restricted in scope) were adjudged too cumbrous. But once more I failed, for 'soil' mechanics was said to be too firmly rooted in engineering literature to be eradicated.

Although we are not warranted in any circumstances in defending the slipshod use of words, the trouble in the present instance lies deeper than the simple question of nomenclature. In my experience, the result of the adoption of the expression 'soil' mechanics is that engineers and chemists who have occasion to consult the literature of 'soils' in this connexion are directed (by way of librarians or bibliographies) to pedological literature and not to the appropriate geological sources of information on unconsolidated rocks—sometimes with unfortunate results.

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# REACTION OF HUMAN SERUM ALBUMIN WITH HÆMATIN AND HÆM

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IT was shown by Heilmeyer[1] that the pigment in the blood serum of certain cases of pernicious anæmia accompanied by a severe "hæmatin jaundice" or "hæmatinæmia" differs from free alkaline hæmatin in that the absorption band is at about 620 mμ instead of at 610 mμ. As this pigment was also obtained by Heilmeyer[2] *in vitro* by adding hæmatin to blood serum, he concluded that "in serum the hæmatin combines with proteins which are only split off on adding an excess of concentrated alkali. Thus in serum we are concerned with the spectrum of a protein-hæmatin and not that of alkaline hæmatin".

The same pigment was discovered independently by Fairley and Bromfield[3] in the plasma of patients suffering from blackwater fever, which is one of the most dreaded complications of malaria. They described this pigment under the name of pseudomethæmoglobin, showing that it differs from ordinary methæmoglobin (1) in having its absorption band at about 623 mμ instead of at 630 mμ; (2) in not being easily reduced by Stoke's solution; and (3) in not reacting with hydrogen sulphide, sodium azide, sodium fluoride or hydrogen peroxide. Fairley and Bromfield have also shown that it is formed when oxyhæmoglobin is incubated at 40° C. for 24–72 hours with human plasma. In 1938, Fairley[4] obtained this compound by adding alkaline hæmatin to human or simian blood sera; he failed, however, to obtain it with the sera of other animals. Since of all the protein fractions of human serum only albumin would give this compound, Fairley changed its name from pseudomethæmoglobin to methæmalbumin. On reduction with sodium hyposulphite a compound was formed which Fairley[4,5] described as hæmalbumin, characterized by two diffuse absorption bands at 573 mμ and 530 mμ which after standing a few minutes were replaced by one very diffuse band at about 574 mμ.

In addition to cases of blackwater fever, where the presence of methæmalbumin was confirmed by Foy and Kondi[6], this pigment was found by Fairley and Bromfield in cases of nocturnal hæmoglobinuria, incompatible transfusion and pancreatic cyst fluid (see Fairley[4]). It is interesting to note that in blackwater fever it is found in the plasma, where it is accompanied by oxyhæmoglobin, but not in the urine, which contains oxy- and methæmoglobin.

The main object of the present investigation was to determine the nature of the compound described by Heilmeyer and Fairley. For reasons which will be given later on, the ferric and ferrous forms of this compound will be referred to as hæmatin-albumin and hæm-albumin respectively.

## Preparation of Hæmatin-albumin

Hæmatin-albumin was prepared as follows: 20 mgm. hæmin are dissolved in 2 ml. 0·1 $N$ caustic soda and made up to 25 ml. with water. To 1 ml. of this solution are added 2 ml. of human serum, human plasma or the albumin fraction prepared from this plasma. The absorption spectrum of the compound thus obtained, together with those of alkaline hæmatin and acid and alkaline methæmoglobin, were determined with the Hilger-Nutting spectrophotometer. Fig. 1 shows that the absorption spectrum of alkaline hæmatin in human serum bears a much greater resemblance to that of free alkaline hæmatin than to those of methæmoglobin, especially as it should be compared not with acid but with alkaline methæmoglobin. As albumin seems to be the only serum protein which gives this compound, hæmatin-albumin is a more appropriate name for it. Moreover, as Fairley and Bromfield[3] have already shown, this compound, unlike methæmoglobin, does not combine with hydrogen sulphide, sodium azide, sodium fluoride or hydrogen peroxide. The absorption spectrum of hæmatin-albumin also differs greatly from that of a parahæmatin, which can be obtained by treating hæmatin with denatured serum proteins.

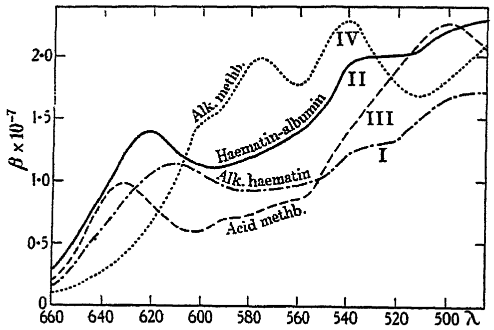


Fig. 1. Absorption spectra of: alkaline hæmatin (I); hæmatin albumin (II); acid methæmoglobin (III); and alkaline methæmoglobin (IV). In all figures the ordinate represents the absorption coefficient $\beta = \frac{1}{cd} \ln \frac{I_0}{I}$, where $c$ is concentration of hæmatin in gram-atom of iron per ml.; $d$ is length of tube in cm.; $I_0$ and $I$ are intensities of the incident and transmitted light respectively. The abscissa represents wave-length in mμ.

*Hæm-albumin.* When hæmatin-albumin is reduced with sodium hyposulphite, the colour of the solution turns from reddish brown to a deep red and its absorption band at 623 mμ is replaced by two bands, α at 570 mμ and β at 540 mμ, the α-band always being much stronger than the β-band. This compound can also be obtained by the addition to hæm of human serum albumin, but not by the addition of any other serum protein fraction. The absorption bands of hæm-albumin, as shown in Fig. 2, are much stronger than those of the free hæm, but much more diffuse and lying nearer the red end of the spectrum than the sharp bands of hæmochromogens obtained from hæm and denatured serum proteins. When human plasma or serum is added to hæm, the first change which is usually observed is the appearance of a very small amount of a hæmochromogen with its characteristic bands; these, however, soon disappear and are replaced by the bands of hæm-albumin. The very small concentration of hæmochromogen which occasionally persists obliterates with its α band the clear space separating the α and β absorption bands of hæm-albumin. It is difficult to say whether this hæmochromogen is formed by the native serum albumin itself, as a transient intermediary stage leading to the formation of hæm-albumin, or by traces of a denatured protein present in the solution.

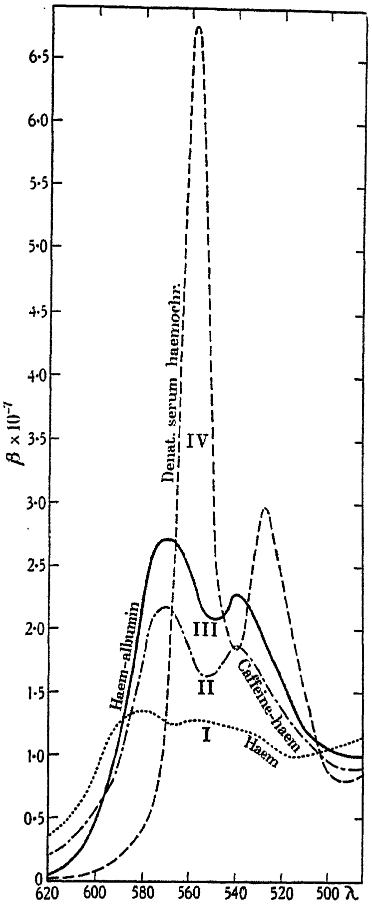


Fig. 2. Absorption spectra of: hæm (I); caffeine hæm (II); hæm-albumin (III); and denatured serum hæmochromogen (IV); $\beta$ as in Fig. 1; the heights of II and III vary to a certain degree according to preparation.

## Nature of Hæm-albumin

The only hæm derivative which bears a strong resemblance to hæm-albumin is caffeine-hæm, which has recently been described (J. Keilin[7]). Both compounds are of the same colour, and the similarity of their absorption spectra is clearly shown in Fig. 2. In the case of caffeine-hæm, it has been shown[7] that caffeine is linked not to the iron but to the porphyrin alone of the hæm molecule, which suggests that in hæm-albumin the protein is also combined with the porphyrin alone. This is strongly supported by the facts that caffeine[7], native globin (Hill and Holden[8]) and "serum proteins" (Haurowitz and Waelsch[9]) form with the free alkaline porphyrins characteristic and spectroscopically recognizable compounds, while among the serum proteins only albumin will react in this way. Finally, by diffusion in gelatine gel and by cataphoresis methods, Gildemeister[10] was able to show that the endogenous coproporphyrins I and III are strongly bound only to the albumin fraction of serum.

## Reaction of Hæm-albumin with Carbon Monoxide

On passing carbon monoxide through a solution of hæm-albumin, its absorption spectrum changes to that of carbon monoxide hæmochromogen, which differs from that of carbon monoxide hæm or carbon monoxide caffeine-hæm in the position and relative height of the two absorption bands (Fig. 3). In hæm-albumin treated with carbon monoxide, the protein therefore appears to combine with the iron of hæm.

It is not surprising that hæm may fail to give a hæmochromogen and yet may form a carbon monoxide hæmochromogen under the same conditions, since it is known that the iron of carbon monoxide hæm has a much greater affinity for nitrogenous compounds than the iron of free hæm. It is, however, impossible to say whether the protein component of this carbon monoxide hæmochromogen is the native serum albumin or a denatured protein present in very small concentration.

It can be said in conclusion that proteins may form with hæm ($Fe^{++}$) three types of compounds: (1) Hæmochromogens: usually given by a denatured protein which is linked with the iron of hæm. (2) Hæm-albumin: given by a native protein linked only to the porphyrin of hæm and forming a compound analogous to caffeine-hæm. (3) Hæmoglobins: where the protein is combined with both the porphyrin and the iron of hæm.

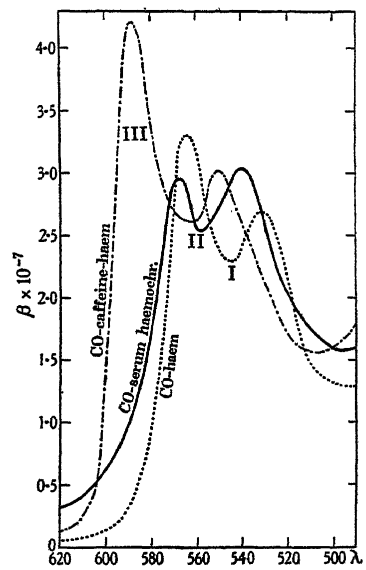


Fig. 3. Absorption spectra of: carbon monoxide hæm (I); carbon monoxide serum-hæmochromogen (II); carbon monoxide caffeine-hæm (III); $\beta$ as in Fig. 1; the heights of I and III vary according to their dispersion but the form remains the same.

I wish to thank Dr. E. F. Hartree for the curves of acid and alkaline methæmoglobins and for the preparation of a pure sample of human serum albumin.

[1] Heilmeyer, L., *Deutsch. Arch. Klin. Med.*, **173**, 128 (1932).

[2] Heilmeyer, L., "Medizinische Spectrophotometrie" (Fischer, Jena, 1933); English translation: "Spectrophotometry in Medicine" (A. Hilger, 1943).

[3] Fairley, N. H., and Bromfield, R. J., *Trans. Roy. Soc. Trop. Med. and Hyg.*, **28**, 307 (1934); **31**, 139 (1937); **31**, 372 (1938).

[4] Fairley, N. H., *Nature*, **139**, 588 (1937) and **142**, 1156 (1938).

[5] Fairley, N. H., *Brit. J. Exp. Path.*, **21**, 231 (1940).

[6] Foy, H., and Kondi, A., *Trans. Roy. Soc. Trop. Med. and Hyg.*, **32**, 49 (1938).

[7] Keilin, J., *Biochem. J.*, **37**, 281 (1943).

[8] Hill, R., and Holden, H. F., *Biochem. J.*, **20**, 1326 (1926).

[9] Haurowitz, F., and Waelsch, H., *Hoppe-Seyl. Z.*, **182**, 82 (1929).

[10] Gildemeister, H., *Z. Exp. Med.*, **102**, 58 (1937).

# COLLAPSE OF DETERMINISM

AT the thirty-first meeting of the Indian Science Congress, which met in Delhi in January 1944, the Congress president, Prof. S. N. Bose, discussed "The Classical Determinism and the Quantum Theory", showing how "physicists have gained knowledge but lost their faith". This was supplemented in the Section of Mathematics and Statistics by B. M. Sen, president of that Section, in his address entitled "The Fundamental Equations of Quantum Mechanics". It is difficult to do justice to this without mathematical symbols, so the following article will be based mainly on Prof. Bose's more general treatment.

Classical physics may be said to have begun with Newton. His laws of motion and theory of gravitation gave an explanation of planetary motion which was so satisfactory that it seemed to provide an infallible means of predicting the motion of the solar system. Laplace went so far as to assert that if a sufficiently vast intellect knew the mass, position and velocity of every particle of the universe at any one instant, and the forces acting on them, then "nothing would be uncertain for him; the future as well as the past would be present to his eyes".

It was difficult to fit the phenomena of light into this scheme, since the discovery of interference had shown that light moves like waves rather than like particles. But Maxwell overcame this difficulty by developing Faraday's ideas about the ether. Newton's absolute space was no longer to be regarded as empty, but as a medium possessing energy and momentum, capable of being strained and transmitting waves. This theory was later extended to explain also X-rays, radio signals, and the $\gamma$-rays emitted by radium. Maxwell's electromagnetic theory was extended by Lorentz into a theory of electrons. The modifications in the Newtonian scheme had left it stronger than before. Almost everywhere was seen the reign of exact laws. It was true that in thermodynamics physicists had to make shift with laws that applied only to large aggregates, but no one doubted that these were derivable by averaging from exact equations which were too numerous to be conveniently considered individually. The derivation of these averages contained the term probability or chance, but it was always pointed out that really there was no such thing, and that every occurrence could be predicted if all the circumstances were known. It was characteristic of the eighteenth century, the 'age of reason', that Voltaire should assert that "Chance is a word void of sense: nothing can exist without a cause", and Linnæus that "Nature does not proceed by jumps".

These beliefs were rudely shaken by the quantum theory. In 1900 Planck, puzzled by the phenomena of heat radiation, made the revolutionary suggestion that the emission of energy is discontinuous. Soon afterwards Einstein made a similar suggestion about the photo-electric effect. Bohr explained the spectra of hydrogen and other atoms by postulating that an electron must pass discontinuously from one orbit to another. These postulates were empirical, put forward so as to lead up to the results of experiment. They succeeded in this, but at the cost of abandoning the established laws of mechanics and electrodynamics. What seemed a greater break with tradition was called for by the theory of relativity, but in fact this theory does not reject causality. It is true that it denies the existence of absolute time and absolute space, but it sets up a new set of absolute laws in space-time which are independent of all axes of reference. Einstein's success in explaining the slight discrepancy in the motion of the planet Mercury, and in predicting the apparent displacement of stars during a solar eclipse, struck the imagination of the public, but really it is quantum theory that clashes fundamentally with classical physics.

At one time there were hopes of a reconciliation through Schrödinger's wave mechanics, but it turned out that the waves in question are only mathematical fictions. They are excellent as a means of calculation, as they can be treated by the familiar methods of differential equations instead of by the unfamiliar matrices of Heisenberg or Dirac's algebra of observables. However, all three methods are equivalent, and all lead to the same startling conclusion, Heisenberg's Principle of Uncertainty. This shows that if we measure the position and momentum of a stream of electrons, the more accurately we determine the position the less accurately can we determine the momentum, and conversely. Some think that this merely expresses the obvious truth that every experiment interferes to some extent with the phenomena we attempt to measure. Others go further, and interpret the principle to mean that we cannot predict the motion of a single particle exactly, owing to the slight variation of the forces on it caused by atomic structure, although we can obtain statistical laws which hold for the average motion of a large number of particles. But a third interpretation go[es] so far as to claim that the existence of causality [is] disproved. Von Neumann claims to have demonstrated that the results of the quantum theory cannot be obtained by averaging any exact causal laws.

Some philosopher-physicists welcome these conclusions, as giving us a hope of escape from the tyranny of an iron law of causation, and assuring freewill to mankind as well as to electrons! However, the majority of physicists regard causality as essential to science, and are hoping to establish a unified theory that will once again reunite all our knowledge into exact causal laws. While the matter is still unsettled, we should do well not to insist on imposing our preconceived ideas upon Nature, but let them evolve and adjust themselves to our growing, if somewhat unmanageable, knowledge of reality.

H. T. H. PIAGGIO.

# THYROXINE: ITS BIOSYNTHESIS AND ITS IMMUNO-CHEMISTRY*

THE suggestion that thyroxine might be formed in Nature from tyrosine through the stage of diiodotyrosine was made at an early stage of the elucidation of the chemistry of thyroxine, and was made more probable when the constitution of the latter was finally determined. Over a number of years several pieces of evidence, all indirect in character, were brought forward in support of this biogenetic hypothesis, which thus came to be generally accepted.

Recently two lines of direct evidence have become available which seem to place the matter beyond doubt. In the first place, the transformation of diiodotyrosine into thyroxine has been effected by purely chemical methods of a character which make

* Abstract of the Croonian Lecture of the Royal Society delivered by Dr. C. R. Harington, F.R.S., on July 13.

it possible to formulate a theory of the chemistry of the process involved. Secondly, by the application of modern biochemical technique, the actual synthesis of thyroxine from diiodotyrosine has been demonstrated in surviving thyroid tissue *in vitro*. The latter type of experiment incidentally offers an opportunity for the analytical study of the action of substances such as thiourea, which inhibit thyroid activity supposedly by interfering with the biosynthesis of the hormone.

Accepting the mechanism of biosynthesis of thyroxine as being satisfactorily established, we are left with two outstanding problems. Is thyroxine itself the actual circulating thyroid hormone, and, if so, by what mechanism does it exercise its effect in the periphery? To the second of these questions no answer can yet be given. Evidence regarding the first is conflicting, and in the attempt to obtain a definitive answer an approach has been made along a new line which raises matters of some general interest. The method is based on the theory, deduced from the known facts of immunological chemistry, that an antigen of which the determinant group is a physiologically active substance should give rise to an antiserum capable of inhibiting the characteristic activity of this substance. Application of this idea to the problem of thyroxine involved the development of a new technique for building up artificial antigenic complexes. Such a complex containing thyroxine as the determinant group has proved to be able to give rise to an antiserum which can inhibit the physiological action both of a protein containing thyroxine, such as thyroglobulin, and of thyroxine itself. The latter observation, together with extension of the experimental method to an entirely different compound, favours the hypothesis that thyroxine itself is in fact the actual circulating thyroid hormone.

## INCIDENCE OF RICKETS IN GREAT BRITAIN

DURING the six weeks from mid-January to the end of February 1943 the British Pædiatric Association carried out a combined clinical and radiological investigation into the frequency of rickets in twenty-three areas of Britain and Ireland*. Out of a total of 5,283 children aged 3–18 months, 106 only were reported to show radiological evidence of rickets. Dr. Percy Stocks, who analysed the returns, concluded that the incidence of rickets, diagnosed radiologically, was 2·5 per cent before six months, 4 per cent during the first year and negligible after the first year. The incidence was highest in Ireland and lowest in South England. In Watford and St. Albans no case was detected even by clinical methods. There is no evidence of any increase in the incidence or severity of rickets during the War. In some of the cities of north England, older children with deformities due to severe rickets may still be seen, whereas the cases found in this investigation were slight and free from any gross deformity. It may be inferred that severe rickets was more common a few years ago.

Two points stand out. First, the number of cases diagnosed by clinical methods was nearly ten times the number diagnosed radiologically. Even the three radiologists who examined the films differed in their interpretations. Obviously, we do not yet know what constitutes evidence of slight rickets. But this disagreement is itself evidence of the mildness of the disease, for there is no mistaking severe rickets.

Secondly, 85·5 per cent of the babies that were considered to have rickets on X-ray evidence had had some form of treatment with vitamin D. On this point the report is disappointing. Examiners were supposed to find out what preparation was used, when dosage began, and the daily dose given; but analysis in terms of the duration of vitamin D prophylaxis and the dosage was not attempted, and the nature of the preparations used is not mentioned in the report. It is little use saying that "scientific evidence has clearly shown that adequate vitamin D administered in an adequate dosage and in a suitable form will prevent rickets", and that "a common cause of rickets is the popular cod liver oil-and-malt", without inquiry into the reasons why 77 out of 4,317 babies who were given vitamin D got rickets. The fashion of handing over the results of an investigation for mechanical analysis by a statistician who may not appreciate the importance of the problems that may be involved has its disadvantages.

* Reports on Pub. Health and Medical Subjects, No. 92. "The Incidence of Rickets in War-time". Pp. 36. (London: H.M. Stationery Office.) 9*d*. net.

## MODERN ASPECTS OF INORGANIC CHEMISTRY

THE presidential address by Prof. R. C. Ray to the Chemistry Section of the Indian Science Congress at Delhi dealt with some aspects of modern inorganic chemistry. After mentioning that research in inorganic chemistry had declined towards the close of the nineteenth century, mainly because of the very rapid development of organic chemistry and the rise of physical chemistry, he pointed out that there are very many new aspects of the subject now being developed.

Prof. Ray went on to describe some interesting developments. Compounds of the inert gases with water, boron fluoride and phenol have been obtained, and compounds with metals such as mercury, and iodine, sulphur and phosphorus are described. A subject which has been fully studied, particularly by Stock, Wiberg, Bauer and others, is the chemistry of the hydrides of boron and related compounds, which are also of great interest in relation to the electronic theory of valency. In this field, Indian workers have made important contributions, particularly Prof. Ray and his pupils, who have also worked on the chemistry of co-ordination compounds, glass and hydrides of metals such as nickel.

Nickel forms two hydrides, $NiH$ and $NiH_2$, and cobalt forms analogous compounds, the heats of formation being comparable with those of the salt-like hydrides of the alkali and alkaline earth metals. The heats of formation of hydrides of some rare-earth metals, zirconium, tantalum and titanium, generally regarded as interstitial compounds, are also of the same order, this suggesting that there can be little difference in the nature of the chemical bond in such substances as zirconium hydride and barium hydride, with nearly equal heats of formation.

Prof. Ray considers that there has probably never been a time when the prospects of inorganic chemistry were so promising as they are to-day, when new methods in physics, physical chemistry and organic chemistry are available.

# EXCAVATIONS AT TRES ZAPOTES, MEXICO*

AN account has now been issued of the first season's work of the joint expedition of the National Geographic Society and the Smithsonian Institution to Tres Zapotes. The site is a large one, and the remains consist of earth mounds with little or no masonry. The deposits are tentatively assigned to three periods, Middle Tres Zapotes *A* and *B* and Upper Tres Zapotes. This nomenclature depends on the existence of a Lower Tres Zapotes horizon, discovered during the work of the second season.

The Middle *A* and *B* deposits were not found in superposition, but there is little doubt about their relative age. On one site, Upper Tres Zapotes was found overlying Middle *A*, but separated from it by 6 ft. of sterile deposit.

Middle Tres Zapotes *A* is associated with large numbers of hand-made, solid clay figurines of archaic type, and although there is always a possibility that they are a late survival in a marginal area, the balance of the evidence favours an early date. The Middle *B* period contains uncremated burials in large ollas. It is marked by the first appearance of painted pottery, and there are contacts with many other cultures, conspicuous among which is the Maya Old Empire. The Upper period contains cremated burials in covered bowls, and the pottery is of great complexity. A curious feature of the site is the paucity of Aztec remains.

The work described was admittedly exploratory and many problems are left unsolved. Some of the results of the work of the second season were already available when it went to press, so it seems a pity that publication was not delayed until they could be incorporated and a fuller picture given. The illustrations are good and clear, but should as a matter of routine have been provided with a scale in every case. The same criticism applies in a greater degree to maps 2 and 3, and to the section which is, rather curiously, designated "Map 6".

G. H. S. BUSHNELL.

* Smithsonian Institution: Bureau of American Ethnology. Bull. 139. An Introduction to the Ceramics of Tres Zapotes, Veracruz, Mexico. By C. W. Weiant. Pp. xiv+144+78 plates. (Washington: Government Printing Office, 1943.) 40 cents.

# FORTHCOMING EVENTS

### Tuesday, July 25

QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Exhibition of Specimens and Discussion.

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN EXPERIMENTAL PHYSIOLOGY—The Registrar, The University, Sheffield (July 28).

LECTURER IN THE ELECTRICAL ENGINEERING DEPARTMENT—The Registrar, Technical College, Sunderland (July 29).

JOHN RANKIN CHAIR OF GEOGRAPHY—The Registrar, The University, Liverpool (July 31).

W. H. COLLINS PROFESSORSHIP OF HUMAN AND COMPARATIVE PATHOLOGY—The Secretary, Royal College of Surgeons of England, Lincoln's Inn Fields, London, W.C.2 (July 31).

SENIOR LECTURESHIP IN THE DEPARTMENT OF METALLURGY of the University of the Witwatersrand—Dr. W. Cullen, 4 Broad Street Place, London, E.C.2 (July 31).

PRINCIPAL OF THE MID-ESSEX TECHNICAL COLLEGE AND SCHOOL OF ART, Chelmsford—The Chief Education Officer, County Offices, Chelmsford (August 5).

ASSISTANT LECTURER IN METALLURGY—The Acting Registrar, The University, Leeds 2 (August 12).

ASSISTANT PHYSICIST to the Sheffield Radium Centre—The Secretary, Sheffield Radium Centre, Royal Infirmary, Sheffield 6 (August 12).

BIOLOGIST at the West Midland Forensic Science Laboratory at Birmingham—The Establishment Officer, Room 320, Home Office, Whitehall, London, S.W.1 (August 12).

LECTURER IN PHILOSOPHY—The Very Rev. the Dean, Christ Church, Oxford (October 15).

LECTURER IN PHYSIOLOGY—The Principal, Nonington College of Physical Education, Bromsgrove.

ASSISTANT PHYSICIST (with experience of the Physics of Radiotherapy)—Mr. S. Clayton Fryers, General Infirmary, Leeds 1.

SCIENTIFIC ASSISTANT (Science Degree) and TECHNICAL ASSISTANT (Arts Degree)—Imperial Bureau of Animal Health, Veterinary Laboratory, Ministry of Agriculture, New Haw, Weybridge, Surrey.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 15, No. 1, June 1943. Compiled by Agnes Elisabeth Glennie, assisted by Janet Lang Hall Keuneman. Pp. iv+86. (London: H.M. Stationery Office.) 4*s*. 6*d*. net. [266

Fitzwilliam Museum, Cambridge. Annual Report for the Year ending 31 December 1943. Pp. 10. Friends of the Fitzwilliam Museum. Thirty-fifth Annual Report for the Year 1943. Pp. 4. (Cambridge: Fitzwilliam Museum.) [266

British Society of Animal Production. Report of Inaugural Meeting, 6th January 1944. General Topic: Cattle Breeding Policies. Pp. 38. (Edinburgh: Secretary-Treasurer, British Society of Animal Production, c/o Imperial Bureau of Animal Breeding and Genetics.) 2*s*. [266

National Physical Laboratory. The Natural Lighting of Houses and Flats with Graded Daylight Factor Tables. By T. Smith and Miss E. D. Brown. Pp. 22. (London: H.M. Stationery Office.) 4*d*. net. [266

Burton-on-Trent Natural History and Archæological Society. Local Records for 1943. Edited by H. J. Wain. Pp. 24. (Burton-on-Trent: The Museum.) 1*s*. [276

Medical Research Council. Emergency Report No. 5 of the Industrial Health Research Board: A Study of Variations in Output. By S. Wyatt, assisted by R. Marriott, W. M. Dawson, D. E. R. Hughes and F. G. L. Stock. Pp. iv+16. (London: H.M. Stationery Office.) 4*d*. net. [276

Lister Institute of Preventive Medicine. Report of the Governing Body, 1944. Pp. 16. (London: Lister Institute.) [276

Nuffield College. Problems of Scientific and Industrial Research: a Statement. Pp. 64. (London: Oxford University Press.) 2*s*. net. [276

A Racial Survey of the British People. Lecture delivered to the Free German Institute of Science and Learning, London, on March 11, 1944. By Dr. R. E. G. Armattoe. Pp. 8. (Londonderry: The Author, 7 Northland Road.) 1*s*. 6*d*. [47

Combine Harvesting in the North, 1943. (N.I.A.E. Publication No. 502/44.) Pp. 20. (York: National Institute of Agricultural Engineering.) 6*d*. [47

Notes on Drying Paints by Radiant Heat (Infra-Red). Pp. 20. (Slough: Imperial Chemical Industries, Ltd.) [47

### Other Countries

Bulletin of the American Museum of Natural History. Vol. 82, Art. 8: Geographic Variation in *Rana pipiens* Schreber of Eastern North America. By John Alexander Moore. Pp. 345–370+plates 61–66. (New York: American Museum of Natural History.) [306

Indian Forest Leaflet No. 57: Furnace Heated Veneer Drying Kiln suitable for the Seasoning of Veneers for the Manufacture of Plywood. By M. A. Rehman. Pp. ii+6. 6 annas; 7*d*. Indian Forest Leaflet No. 60: A Short Note on the Beedi Leaf Industry. By Jagdamba Prasad. Pp. iii+12+2 plates. 6 annas; 7*d*. Indian Forest Leaflet No. 61: Kiln Drying Schedule for Seasoning of Veneers. By M. A. Rehman and S. M. Ishaq. Pp. ii+7. 6 annas; 7*d*. Indian Forest Leaflet No. 64: The Growing of *Cryptostegia grandiflora* as a War Time Emergency Plantation Crop. By A. L. Griffith. Pp. iii+10. 4 annas; 5*d*. (Dehra Dun: Forest Research Institute.) [47

Indian Forest Bulletin No. 121: Tests on the Suitability of Indian Woods for the Manufacture of Textile and Jute Mill Accessories, Part 1: Substitutes for Persimmon and Cornel for Cotton Mill Shuttles. By M. A. Rehman and Chheda Lal. Pp. 9. 4 annas; 5*d*. Indian Forest Bulletin No. 122: Tests on the Suitability of Indian Woods for the Manufacture of Textile and Jute Mill Accessories, Part 2: Care and Seasoning of Wood for Bobbins, Picker Arms, and Jute Mill Rollers. By M. A. Rehman. Pp. 7. 4 annas; 5*d*. (Dehra Dun: Forest Research Institute.) [47

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series A, No. 57: Technological Reports on Trade Varieties of Indian Cottons, 1943. By Dr. Nazir Ahmad. Pp. ix+84. 1.8 rupees. Technological Bulletin, Series A, No. 58: Technological Reports on Standard Indian Cottons, 1943. By Dr. Nazir Ahmad. Pp. iv+103. 1.8 rupees. Technological Bulletin, Series A, No. 59: Spinning Tests on Mixtures of Staple Fibre with Indian Cottons. By Srinagabhusahana and Dr. Nazir Ahmad. Pp. 27. 12 annas. (Bombay: Indian Central Cotton Committee.) [47

Indian Forest Records (New Series). Silviculture, Vol. 4A, No. 4: Yield and Stand Tables for Sal (*Shorea robusta*, Gaertn.f.) High Forest. By A. L. Griffith and Bakhshi Sant Ram. Pp. ix+171–287+4 plates. (Delhi: Forest Research Institute.) 2.14 rupees; 4*s*. 4*d*. [47

U.S. Department of Agriculture. Technical Bulletin No. 869: Strains of the European Corn Borer in the United States. By K. D. Arbuthnot. Pp. 20. (Washington, D.C.: Government Printing Office.) 10 cents. [47

# NATURE

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## CONTENTS




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## VETERINARY EDUCATION IN GREAT BRITAIN

IN a leading article in *Nature* of January 8, 1944, the existing constitution and powers of the Royal College of Veterinary Surgeons, and the system of training and examination of British veterinarians was outlined. The key position of the veterinarian in the future, invested, as he must be, with the care of animals upon which our meat, egg and milk supplies depend, was then emphasized, and the interdependence of veterinary medicine and the agriculture from which we derive other vital food supplies was also pointed out. The desirability of a much closer association between the veterinary and the medical professions was also discussed. In the same issue of *Nature*, reference was made to a paper by Major J. M. Smith, in which he made very clear the vital part played by the veterinarian in the affairs of the British Colonies.

A Committee on Veterinary Education in Great Britain was appointed in 1936 by the Government, and issued its first report in 1938. In 1943 the same Committee was asked to reconsider its first recommendations, because, as the Minister of Agriculture wrote to Dr. T. Loveday, vice-chancellor of the University of Bristol, who is its chairman, there have been since 1938 great changes in the position and prospects of agriculture in Great Britain. The Government, wrote Mr. Hudson, intends to maintain after the War a healthy and well-balanced agriculture as an essential and permanent feature of its national policy; and livestock, especially dairy herds, will need adequate care. The best possible training for the veterinarian of the future, continued Mr. Hudson, is therefore of vital importance to agriculture, and substantially greater numbers of veterinarians will be required. The Committee has in consequence met again, and its second report has now been issued (London: H.M. Stationery Office, 6*d*. net), and will presumably go before Parliament for discussion.

The Committee emphasizes that its revised recommendations are intended to secure, not merely an efficient system of training for the veterinarian, but also what it considers to be the best possible training. It also emphasizes that the revised recommendations are based on the assumption that British agriculture will, in fact, be maintained in a healthy and prosperous condition, "and will not be allowed to fall back into the state of uncertainty and depression which progressively prevailed between 1920 and 1939". The revised recommendations do not supersede those of the Committee's first report, except in certain important and possibly controversial particulars; and the main conclusions of the first report are printed in Appendix I for comparison. A point strongly emphasized by the Committee is the urgent need for inquiry into the growing evil of unqualified veterinary practice, a recommendation to which effect has just been given (*Nature*, July 22, p. 111).

There should not be—indeed, there is not—in the mind of anyone who has given even a thought to the cost of animal disease in Great Britain alone, any doubt of the need for veterinarians, or of the financial

saving which expansion of their work could effect. Appendix III of the report gives details of the national loss due to various diseases of farm livestock. The Committee estimates that the total cost to the nation is not less than thirty million pounds a year, and rightly considers that the bulk of this loss is preventable, but only if much more money is spent on veterinary training.

Dealing with the future demand for veterinarians, the Committee revises its earlier estimate that about 150 veterinarians would be required annually between 1938 and 1942 and 115 afterwards. Actually 571 veterinarians qualified in the years 1940, 1941 and 1942, without causing unemployment in the profession. The Ministry of Agriculture and Fisheries, bearing in mind its plans for the future expansion of the State veterinary service and the Government's use of the services of private veterinary practitioners, now estimates a demand for 220 veterinarians a year for about ten years, with a possible reduction to 150 a year later. The reasons given by the Committee for the increasing demand for veterinarians are the increasing appreciation by the farmer and the public that the veterinarian is the guarantor of the nation's food supply; the fact that the Government seems to be aiming at a quarterly examination by veterinarians of every dairy herd in the country (it is estimated that about 2½ million dairy cattle, which is about 80 per cent of all the dairy cattle in Great Britain at present, get no regular veterinary supervision); extension of veterinary supervision of meat production and of its control on the way to the market; and increases in the requirements of owners of riding horses and small animals. Most of the witnesses consulted agreed to this figure of 220; but others, including the Royal College of Veterinary Surgeons, hesitated to do so, partly because they feared that the Government's present policy would not be carried on and partly because they feared that the unqualified practitioner might reduce the work of qualified men.

The Committee does not think that qualified men from Eire will come over to practise in Great Britain in sufficient numbers to affect the demand, and it recalls that most of the veterinarians practising in British Colonies are trained in Great Britain. This Colonial demand will, the Committee thinks, increase rather than diminish, because, as the control of the major diseases of livestock in the Colonies, which has occupied and is now occupying the attention of Colonial veterinarians, becomes established, other diseases which have been masked by these major diseases will need attention, and these are likely to require more men for their control. Because the progress of pastoral Colonial peoples depends largely upon adequate production of dairy and other livestock products, this branch of the work of the veterinary profession is likely to become increasingly important. The Committee's recommendations are therefore framed on the estimate of 220 veterinarians a year for ten years, and it sees no reason at all why this demand should fall to 150. It is suggested, in fact, that the figure 220 may prove to be too low. In support of this view, the report includes a table based on information supplied by the Allied Post-war Requirements Bureau, which shows that the number of veterinarians per million of the large domestic animals is 94·4 in Great Britain, 98·8 in France, 123 in Norway, 140 in the Netherlands, 148 in Denmark, 149 in Germany, and 247·8 in Switzerland. In the United States the corresponding figure is only 60, but much farm stock in that country is kept under ranch conditions; further, reforms in veterinary education and increases in the numbers of veterinarians are now being urged and planned. The table indicates that the number of veterinarians per million of the population in the United States is twice as great (109) as it is in Great Britain (50·2) and the United States figure compares favourably with the corresponding figures cited for other European countries.

The rest of the report deals with the number and location of the veterinary schools, the functions of the Royal College of Veterinary Surgeons, the licence to practise, the association of veterinary training with the universities of Great Britain and with finance. The training of 220 veterinarians a year cannot, the Committee decides, be accomplished by the expansion of the existing four veterinary schools at London, Edinburgh, Liverpool and Glasgow. Eire and its veterinary school at Dublin are not considered. The ideal size for a veterinary unit is, the Committee concludes, one which will provide thirty graduates a year, and all the universities consulted agreed to this figure. The Liverpool school cannot expand beyond this, which it now achieves. The existing Glasgow College is inadequate. If thirty men a year are allocated to this school, which would become an integral part of the University of Glasgow, the London and Edinburgh schools would have to produce 160 graduates a year between them, which would mean about 1,000 students in these two schools combined. The Committee considers that this is too many. Complaints of overcrowding are already universal, and the Committee agrees that they are well founded. It suggests that the number of students at the London school should be limited to 325, and at the Edinburgh school to 275, and that the field stations attached to each school, recommended in the Committee's first report, and again emphasized in this second one, should relieve the pressure on these schools by providing most of the clinical training. London and Edinburgh should then be able to supply a hundred veterinarians a year.

Provision would then be required for sixty more, and the Committee proposes the establishment of two new colleges, one at Bristol and one at Cambridge. There would thus be six veterinary schools in Great Britain, each with a field station and preferably with a hospital for large animals. Veterinary students would receive farm pupilage for not less than six months in the care of normal livestock and also would spend at least six months with a practising veterinarian. There would be provision, in the normal estimates of each school, for continuous research, and bursaries and graduate scholarships would be provided. It is rightly emphasized that these should be of sufficient value to enable the recipients to

take a full part in university or college life. Private endowment of veterinary education and the work of the Veterinary Educational Trust are also commended.

The reasons for the selection of Cambridge and Bristol as the sites of these two new centres need not be set out in detail here. At Cambridge the veterinarian would be in contact with experts in all the branches of science and the arts, and also with the various agricultural institutes there. At Bristol a veterinary college would, the Committee thinks, be well placed to serve the area south and west of a line drawn between Aberystwyth, Worcester, Swindon and Weymouth. A veterinary school in Wales was considered and urged by the Welsh Council of Agriculture; but the Committee felt that each veterinary school should be in close touch with a large and important grazing district, should be able to establish a field station within easy reach, should have suitable accommodation for the pre-clinical years, should be in a centre possessing good medical and agricultural schools and should be remote from other veterinary schools. Although Cardiff and Aberystwyth both fulfil some of these requirements, the Committee concluded that Bristol could best serve south-western England and central and south Wales, while Liverpool could serve north Wales. Not everyone will agree with the Committee's rejection of the claims of Wales to its own veterinary school. The Committee says that, if the demands of the future require more centres, the claims of Wales will have to be considered. Many will think that they should be satisfied now, one reason being that Wales, like Scotland, presents rather special veterinary and agricultural problems which should be studied at such a Welsh centre.

The requirements detailed by the Committee for the choice of sites for veterinary schools are, however, intimately bound up with one of the most important of the Committee's recommendations. This is the Committee's view that the best possible training for the veterinarian can only be obtained by persuading the universities to undertake the responsibility for it. This recommendation is an extension of the recommendation in the Committee's first report that there should be a close connexion between veterinary education and the universities. It involves far-reaching changes, some of which are not, as recent correspondence in *The Veterinary Record* shows, acceptable to many members of the veterinary profession. The Committee's ideal is that veterinary schools should become parts of universities in the same sense as medical schools. This is already so in Liverpool. The Committee is satisfied that the following conditions should apply to all university schools of veterinary medicine. The necessary money should be provided by the State; the degree in veterinary medicine given by the university should become a registrable qualification; and the university should have a measure of control over the instruction given, and over the university examinations held, similar to that "generally exercised in the case of medical degrees".

While the Committee "favours the idea" that the universities concerned should establish new faculties of veterinary medicine, it does not make any definite recommendation on this point, because "so much depends on the conditions prevailing at each individual University". Many will regret the lack of decision in this matter. If veterinary education is to be undertaken by the universities at all, it must certainly be given, from the very beginning, an equal status with medicine, agriculture or any other university study which constitutes a faculty. It would be emphatically insufficient, for example, to create a department of veterinary medicine within, or subordinate to, any other faculty. The veterinary profession can only be given its legitimate place in any university by the creation of a faculty of veterinary medicine of full status, the affairs of which would be governed, like those of other faculties, by the veterinary staff in co-operation with other university teaching officers. In no other way would it be possible for the veterinary teacher as well as the veterinary student to take their full part in university life and to experience its full effects. By administering and teaching in a full veterinary faculty the veterinarian would, moreover, be in the best position to introduce effectively into the university those new problems and new spheres of work which could be such valuable additions to university studies. This contribution which veterinarians can bring to the universities is too easily overlooked. It has a very real national importance and no university can afford to neglect it.

While it is clear that the Committee desires the creation of faculties of veterinary medicine of independent status, it is no less clear that it emphasizes its further recommendation that university degrees in veterinary medicine shall be registrable qualifications. There is a lack of clarity in the report on this point which requires elucidation. The Committee recommends that university degrees in veterinary medicine shall be registrable by the Royal College of Veterinary Surgeons and by that College alone; and it also recommends that the Royal College shall continue its own examinations and shall continue to grant the diploma of M.R.C.V.S. on the results of these examinations, which would presumably be held only in those existing veterinary colleges which do not, for one reason or another, become constituent parts of universities. There would thus be two possible veterinary qualifications—a university degree in veterinary medicine, and the diploma of M.R.C.V.S. granted only by the Royal College of Veterinary Surgeons on the results of its own examinations. The Committee's recommendation is that the Royal College of Veterinary Surgeons should be the only body legally empowered to register either or both of these qualifications, and to grant a licence to practise veterinary medicine. The recipient of a university degree in veterinary medicine would therefore have to register with the Royal College of Veterinary Surgeons, just as the recipient of a university degree in medicine or surgery must place his name on the Medical Register before he can practise.

It would further be necessary, the Committee thinks, to create a body independent of the univer-

sities which would be empowered to secure a minimum standard of qualification to practise veterinary medicine. It is proposed that the Council of the Royal College of Veterinary Surgeons should be given this power. The College would therefore control both the education of veterinarians and their licence to practise. Its constitution would be widened and it would be given powers similar to those granted to the General Medical Council by the Medical Acts of 1858 and 1886, the relevant portions of which are quoted in Appendix VI of the Committee's report. These Acts would empower the new Council of the Royal College of Veterinary Surgeons to appoint inspectors who would have the right to attend, and report on, the examinations held at any centre, and to ask for details of the courses of instruction provided. If either these courses or the examinations were not considered adequate, the Council of the College could report to the Privy Council, which could declare that such courses or examinations should not qualify for a registrable qualification in veterinary medicine. The new Council's authority would also extend to veterinary schools which are not parts of universities.

It would thus seem that the Royal College of Veterinary Surgeons would retain all reasonable control of the profession. Some veterinarians have said that the proposals of the Committee involve the relinquishment by the College of the sole control over the educational standards of the veterinary profession in Great Britain which it now exercises; but other veterinarians have replied to this that, in actual fact, the College does not at present exercise this control. It controls only the examinations, and has no control over the instruction given in the existing veterinary colleges, nor any over the time which is given to the study of individual subjects in them.

Objections have also been raised to the Committee's proposal to bring into the new Council of the Royal College of Veterinary Surgeons certain persons who are not veterinarians. Here it should be emphasized that precisely four, and four only, of the thirty-three members of the new Council need not be veterinarians. The Committee does not, let it be noted, say that these four must not be veterinarians. They are to be appointed by the Crown; and no doubt the Crown will appoint, if not veterinarians, then men who have shown themselves to be sympathetic to the veterinary profession or to have contacts with it which have given them an understanding of its problems and aspirations. The profession itself is, moreover, to be given the majority vote in the new Council; for seventeen of the thirty-three members would have to be freely elected by the profession precisely as the whole Council is now elected. The other twelve would be nominated by the universities and the veterinary colleges which would teach and grant the single registrable qualification. Twenty-nine members of the new Council would be veterinarians and a majority of the whole Council would have to be freely elected by the profession. If such a Council could not safeguard every vital interest of the profession, then the profession itself would alone be to blame. It is worth remembering, also, that the report of this Committee is not a series of edicts from which there is no appeal. It is a number of recommendations based on evidence taken from veterinarians themselves and from teachers of veterinarians, as well as from educational experts all over Great Britain; and these recommendations are put forward for calm discussion in Parliament and elsewhere.

The Committee was specifically asked to devise plans for the best possible training for the veterinarian, having regard to the anticipated expansion of the profession, and it believes that university training alone can effect this. There will be few who will not agree with this view. Many veterinarians are already taking university degrees of one kind or another as well as their veterinary training. This means, as the Committee points out, that they have to take two or more courses, with the corresponding examinations, and must thus waste much time. One result, however, is that increasing numbers of veterinarians are learning by experience the advantages of university life, and most of them will be strongly in favour of the Committee's insistence on university education. They are by no means uncritical of the universities. No progressive mind is. Most people who have given any thought to the universities desire reforms of one kind or another. It is, in fact, one of the most valuable results of university education that it teaches men the folly and sterility of stagnation and satisfaction.

Veterinarians, moreover, like all men of science, must, as members of scientific research teams, experience that cultural effect of practical scientific work which teaches men to sink their own desires and differences and to pull their full weight for the achievement of a common aim. They may think that this is enough; or even that it is better than a university education. But surely the best university education is essentially an extension of this spirit, not only into the non-scientific world, but also into the social unit, the nation and finally the world. Men experiencing it cannot fail to become, as the Committee suggests, better men. "Universities," wrote Dr. John Murray in the *Sunday Times* (May 7, 1944), "can only vivify each new generation by witnessing to the common body of culture"; and he rightly pointed out that, in an age of specialism, we must compensate for specialism by common study carried out in a community. The logic of events, he writes, is making the universities the meeting ground of the youth of Britain and of every other land; it is making them "agencies of mutual understanding, organs of a world spirit of amity and conciliation". The veterinarian should be included in this Parliament of Youth, for his work has a vital place in the development of civilization. Dr. Murray thinks that the future of the universities may lie, not in great cities, but in small ones, in old and historic places, in the countryside where there is continuity with the past, in "places such as Oxford was and Cambridge still is". It is not irrelevant to add to these the Exeter from which Dr. Murray writes, and where he presides over an educational community which draws to its

happy atmosphere students from all over the world. It seems a pity that this College, situated as it is in the middle of one of the greatest agricultural districts of England, cannot be given a part in the training of the veterinarians whose services that district must have. Would it not be possible, for example, to link it with the new centre at Bristol in some form or other ?

Another aspect of the Committee's report remains for comment. The Committee adopts, on more than one page of its report, what some will consider to be an insufficiently firm attitude to the universities. The Committee, for example, "strongly urges" the universities giving registrable veterinary qualifications to include practising veterinarians among their external examiners, and to consult the Council of the Royal College of Veterinary Surgeons when they are appointing them. The College, of course, insists on the inclusion of veterinary practitioners as examiners in the clinical subjects, and many will think that the universities should be plainly told that they must establish a rule so obviously essential. Elsewhere the Committee says that it is "encouraged to believe" that one of the universities concerned "might be prepared to establish a School of Veterinary Medicine" such as the Committee proposes and to grant a degree in veterinary medicine, subject to the conditions which have been mentioned above. Of another university the report says that the Committee understands "that the university would not be adverse in principle" to its proposals. The position at another university centre is described as "exceptional". The remaining two universities have, however, expressed their willingness to carry out the Committee's proposals. There would thus appear to be a need for a reminder that all universities, jealous as they must be of their independence, also have a public duty in a matter of such national importance as this.

There is a spirit abroad among the young men of to-day which will not brook anything but a progressive spirit among its educational leaders. Certainly the veterinary profession has demonstrated that there are among its leaders men who are progressive, able and mellowed by a culture which extends beyond their own science and art. They have proved themselves to be wise administrators as well as first-class practitioners of their profession. They are, like the medical men, determined to uphold their just rights, but they are not willing to do this obstinately or to refuse that patient but firm conciliation which has always been the mark of the ablest men throughout the centuries. They are aware, like the leaders of the medical and other professions, that conciliation, reasonableness and wise judgment are required of all responsible men at a time when the whole world is being reconstructed on a basis of good-will and the best possible service by all for the greatest good of the whole. It is not to be expected that the authorities of British universities will be any less conscious of their national responsibilities, nor any less willing to reach a speedy and just solution of the relatively minor difficulties presented by the recommendations of this report.

# THE SUPREMACY OF REASON

## '42 to '44

A Contemporary Memoir upon Human Behaviour during the Crisis of the World Revolution. By H. G. Wells. Pp. 212. (London: Martin Secker and Warburg, Ltd., 1944.) 42*s*. net.

MR. WELLS is indefatigable, and advancing years seem in no way to diminish the output or readiness of his pen. This "Contemporary Memoir" consists of two parts with three appendixes, the sequence and relation of which are by no means so apparent as they might be. Even the sedulity which Mr. Wells demands of his reader at the point of his preface might well fail to reveal a common theme or dominant *motif*. Moreover, only part of the book is new—how much even one with the full range of Mr. Wells's more recent writings in front of him might not be able to say with any certainty—and the high price will scarcely dispose a reader to excuse the compilation of so much material from previous writings without at least some biographical reference. Evasiveness or indefiniteness on this point is not confined to his own writings, for in this matter Mr. Wells is thoroughly inconsistent. Sometimes he provides a complete reference to a book that has interested him, but he quotes several pages from what is presumably General Smuts's address to the South African Institute of Race Relations in January 1942 without bothering to insert the line that would help a reader who wished to confirm his quotation or consult the full text to trace the New Africa Pamphlet No. 2, "The Basis of Trusteeship", in which that speech has been printed.

What might be overlooked in the journalist can scarcely be condoned in a more serious study that claims to be an autobiography of ideas, in some ways continuing, supplementing and expanding Mr. Wells's earlier "Experiment in Autobiography". Moreover, as giving the mature views of Mr. Wells as philosopher summing up his position after a life-time of work and study, the book might be placed in the philosophical class. That claim may indeed be contested, for if Mr. Wells is a true philosopher, can his irrepressible vitality and imagination ever allow him to be mature ? There are serious passages in the book and flashes of the brilliant and imaginative writing we expect from him. For the most part, it is journalism —inconsistent, sometimes irrelevant, even dogmatic or bullying, but always Mr. Wells, as when the kindly *aria* in praise of Beatrice Webb breaks the thundering notes of the grand *oratorio* of the private —or is it the public ?—hates of Mr. Wells which occupy so much of the second part of the book. Mr. Wells tries hard at times; but his comments are seldom as detached as they purport to be. They are usually lively, often intemperate—as he readily admits—and sometimes stimulating and suggestive, which after all is one reason why this author is read.

In the first part of the book, Mr. Wells discusses the reasons for the recrudescence of cruelty in this modern world, and ends on the optimistic note that the idea of a new world based on a universally valid declaration of equal human rights is now making headway against every device of its antagonists. In this part Mr. Wells is happily irrelevant, and in view of the warning to the reader in his preface, one may well wonder whether he has not started off by deliberately making his argument obscure, or whether in some Puckish mood Mr. Wells has not written

the whole book as a test for reader or reviewer to see what they would make of it. Certainly this first part completely falsifies the claim on the wrapper that it is detached from immediate contemporary political and social developments. Did Mr. Wells make that claim himself with his tongue in his cheek, or does he also need deliverance from the writer of 'blurbs' ?

The idea of a declaration of the universal rights of man is the most substantial feature of the second part of the book. Entitled "How We Face the Future", and promising to study the drama of John Ball and Richard II in modern dress, its exposition of the idea of the universal rights of man proves but the overture to the oratorio of hate. Beginning with the Communist Party the tempo quickens and the stops are pulled out as Mr. Wells indulges in his dislikes of the War Office, Mr. Alexander, President Roosevelt, General de Gaulle, Sir Samuel Hoare and Lord Vansittart, culminating with Sir Richard Acland and the Roman Catholic Church as a grand finale.

There is nothing scientific in all this, but the objects of Mr. Wells's dislikes appear to him to have a common feature in being obstacles to the penetration of a scientific spirit and outlook into public affairs. It is obscurantism and prejudice, whether professional, political or religious, that arouse his wrath. His tirade against the Admiralty in the section "Invention and Professionalism apropos the U-boat War" is inspired by the Admiralty's apparent reluctance to examine thoroughly an idea for the use of the helicopter; but Mr. Wells prejudices what appears to be a *prima facie* case for searching official inquiry by his loose reference to "hundreds" of battleships.

The three appendixes to the book are, first, a thesis accepted by the University of London for the doctorate of science "On the Quality of Illusion in the Continuity of the Individual Life in the Higher Metazoa, with Particular Reference to the Species *Homo sapiens*" ; second, a memorandum on the relation of mathematics, music, moral and æsthetic values, chess and similar intellectual elaborations to the reality underlying phenomena ; and, third, a memorandum on survival. The last is a reiteration of Mr. Wells's conviction, so long and consistently and sincerely expounded, that the survival of man and of civilization depend upon our overcoming the stupid and uncritical resistance to thought and inquiry. Knowledge or extinction, he maintains, is the only choice for man. He has no use or place for the emotions or for tradition : reason and the intellect must be the sole controlling factors. Exactly how science alone is to reorganize human affairs for a new and happier adaptation of our interests and emotions to the state of affairs which the brighter factors of our life have brought about is not clear.

Mr. Wells, though intensely individualistic himself, and with the faculty for looking at things at unusual angles, does not believe in individualism, and the main theme of his present thesis is that the integrality of the individual is a biologically convenient delusion. Personality is an illusion ; yet, he argues, it is compatible with an impersonal overriding intelligence. But how in default of leadership and personality a new and broader education system throughout the world is to issue in a federated political and economic order and a common fundamental law of human rights, in which a great impersonal society with an unprecedented range of variability is to develop, is never explained. The nearest approach to an explanation is the comment, in a chapter on "The Propaganda of World Unity", that such bodies as the Combined Raw Materials Board, the Production and Reserves Board, the Food Board, the Middle East Supply Centre, which we have already been obliged to set up for war purposes, must be developed for the establishment of world order when hostilities cease, and that from them world control of the new order must spring. Beneath the shelter of these world-wide settlement commissions and their over-riding powers, and so long as the universal rights of man are respected, national governments, great and small, can continue to develop the idiosyncrasies of their various nations and peoples, freely and securely.

Mr. Wells's chief hope is this functional line of advance, and his undying confidence in the supremacy of reason is as conspicuous as the sincerity of his passion for reform.

This is not one of Mr. Wells's great books, and no one should read it as an introduction to his work. But in a book that insists so strongly on the illusion of personality, it is Mr. Wells's own personality that is dominant, sincere and forceful. If his cosmic imagination is only evident here and there, and his philosophy uncertain, there is enough of the real Wells in this testament of impatience to redeem its shortcomings for those who measure it against earlier and finer books which have set the standard of judgment. R. BRIGHTMAN.

## FOURIER SERIES

Fourier Series

By G. H. Hardy and W. W. Rogosinski. (Cambridge Tracts in Mathematics and Mathematical Physics, No. 38.) Pp. viii+100. (Cambridge: At the University Press, 1944.) 8*s.* 6*d.* net.

THIS important new Cambridge tract is concerned with the modern developments of the *mathematical* theory of Fourier series. The character of this theory was radically altered during the decade 1900–10 by three fundamental discoveries : (1) the Lebesgue integral (1902–6) ; (2) the Fejér theorem (1904) ; (3) the Riesz-Fischer theorem (1907).

For any function $f(x)$ defined uniquely in the interval $(-\pi, \pi)$ to possess a Fourier series, it is sufficient that

$$\int_{-\pi}^{\pi} f(x)\, e^{inx}\, dx$$

should exist for all integers $n$ including zero.

Lebesgue's definition of the integral, considerably more comprehensive than those which had preceded it, brought an immediate extension to the class of functions possessing Fourier series, and it has by now almost entirely superseded the older integrals in the mathematical treatment of this and allied subjects.

The classical ideas of convergence had been investigated thoroughly in regard to Fourier series by Dirichlet and others, and had shown themselves to be insufficiently powerful to deal satisfactorily with the problems that had arisen. In this connexion, Fejér (using Cesàro's process of summation by arithmetic means) succeeded in establishing the fundamental result that any function which is continuous or possesses simple discontinuities gives rise to a Fourier series which is (uniformly) summable $C,1$ to the 'correct' sum.

The combination of these two new ideas produced the now famous Fejér-Lebesgue theorem, which shows, in modern language, that summability $C,1$ is a 'Fourier-effective' process; that is to say, it sums the Fourier series to the 'correct' sum almost everywhere. This, it is worthy of note, is in marked contrast to classical convergence; in fact, Kolmogoroff has recently demonstrated the existence of Fourier series which are *nowhere* convergent.

F. Riesz and E. Fischer, working independently, were finally able to formulate a precise converse of the old formal result known as Parseval's theorem (1799). The existence theorem bearing their name is to the effect that, if $\sum_{n=1}^{\infty}(a_n^2+b_n^2)<\infty$, there exists a measurable function, with an integrable square modulus (that is, a function of the Lebesgue class $L^2$) with these numbers as Fourier constants, and furthermore that the partial sums of the Fourier series converge *in mean* to this function. With reference to this it should be observed that the Lebesgue integral plays an indispensable part in the proof; in fact, the theorem is *false* for any definition of the integral narrower than that of Lebesgue.

With these fundamental ideas in view, the reader will find in this tract an admirably lucid and precise account of most of the major developments which have taken place during the last forty years. The authors have used the Lebesgue definition of the integral throughout, at the same time indicating those theorems which remain true, *mutatis mutandis*, if Riemann or Cauchy integrals be used. To say that a given trigonometrical series is a Fourier series is to say that a certain set of integral equations has a solution, and the meaning of such a statement plainly depends on the type of integral used. A definition wider than that of Lebesgue, for example, would in general increase the class of functions possessing Fourier series, just as a narrower one would decrease it.

After a preliminary chapter consisting principally of introductory concepts, there follows a discussion on orthogonal systems of functions of $L^2$. Any theorem proved for a series of such functions is true *a fortiori* for an *ordinary* Fourier series in virtue of the orthogonality of the sequence $\{e^{inx}\}$, and this affords an interesting (and indeed valuable) logical approach to the theory. In most cases such theorems on Fourier series are admittedly deducible by independent (though not necessarily more elementary) methods and, where possible, the authors have provided alternative proofs.

The standard tests for convergence, those of Dini, Jordan, de la Vallée Poussin and Lebesgue, and their relation one to another, are then dealt with, and their analogues for the conjugate series (not necessarily itself a Fourier series) are also provided.

Following Toeplitz, the authors then investigate the application of generalized summation processes to trigonometrical series; in particular the Cesàro and Abel methods, both possessing positive kernels, are shown to be Fourier-effective.

Finally, a chapter dealing with 'uniqueness' theorems is supplied, culminating with the result of de la Vallée Poussin that if a trigonometrical series converges, except possibly in an enumerable set, to a finite integrable function, then it is necessarily the Fourier series of that function.

The entire tract is a model of clarity and precision, the authors having spared no pains to ensure that the reader shall never be at a loss to follow them, even through their most intricate arguments. It is true that there are one or two paragraphs (for example, in the proof of Gergen's modified form of Lebesgue's convergence test, and again in the construction of a Fourier series which diverges almost everywhere) where the logic is convincing, but where a little explanation of the reasons underlying the mode of building up the argument would aid comprehension; but for this omission we must doubtless blame the severe compression, without which it would have been impossible to display such a wealth of valuable material within the short space of a hundred pages.

This tract cannot fail to be of inestimable value, particularly as a 'curtain raiser' to Zygmund's standard treatise.

J. H. PEARCE.

## AUSTRALIAN ORCHIDS

### The Orchids of New South Wales

By the Rev. H. M. R. Rupp. Pp. xv+152. (Sydney: National Herbarium, Botanic Gardens, 1943.) 9s. net.

When the first handbook of the New South Wales flora was published in 1893 it contained descriptions of one hundred and seventy-three orchids, whereas in the work under review the Rev. H. M. R. Rupp provides descriptions of no less than two hundred and forty-eight. The large majority of these orchids are terrestrial species, only fifty-two being epiphytes, and they include a number of interesting genera, among which may be cited Prasmophyllum and Cryptostylis. Of the former, rather more than half the eighty known species are dealt with here, while of the latter twenty species are known and three occur in New South Wales. In all the members of these two genera the inferior ovary, instead of exhibiting the half-twist through 180°, as in most orchids, undergoes a complete twist during development so that the flower has a normal orientation but is reversed compared with most orchid flowers. One naturally thinks of the analogy with the leaves of Alstroemeria, where most species exhibit a twist of the base that brings about complete reversal, while in a few an edge-on position of the leaf is assumed as the leaf-base only undergoes a half-turn. The changes, both anatomical and morphological, which accompany such complete reversal, may be profound, and the fact that these ensue, rather than, what would appear simpler, namely, complete suppression of twisting, suggests a sort of momentum in evolution, since further genetical changes in the same direction appear to be more readily achieved than such as would be accompanied by a reversion to the ancestral condition.

The text of this work furnishes keys to the genera and species, and descriptions of the latter, accompanied by an account of their distributions. The twenty-three full-page figures illustrate the habit and floral structure of some of the more important types. The first descriptions of more than thirty of the species of this region we owe to the author, which gives some indication of the extent to which this aspect of systematic botany in New South Wales is indebted to his studies.

The Rev. H. M. R. Rupp belongs to that honoured band of gifted amateurs who have devoted their leisure to taxonomic studies, and the present volume is a valuable contribution to the new Flora of New South Wales to which the author looks forward.

E. J. SALISBURY.

# WILLIAM GILBERT AND THE SCIENCE OF HIS TIME*

By PROF. SYDNEY CHAPMAN, F.R.S.
Imperial College of Science and Technology

THIS four hundredth anniversary of William Gilbert's birth† offers an occasion for a brief review of his influence on the science of his time (apart from medicine), and of his researches and book on magnetism and electricity, the firm base of his enduring fame.

These researches, extending over about eighteen years**, might seem ample to occupy the leisure of so eminent and active a physician. But the Elizabethan physicians were notably versatile, as Bacon thus remarked:

"For in all times, in the opinion of the multitude, witches and old women and impostors have had a competition with physicians. And what followeth? Even this, that physicians say to themselves, as Solomon expresseth it upon an higher occasion, 'If it befall to me as befalleth to the fools, which should I labour to be more wise?' And therefore I cannot much blame physicians, that they use commonly to intend some other art or practice, which they fancy, more than their profession. For you shall have of them antiquaries, poets, humanists, statesmen, merchants, divines, and in every of these better seen than in their profession." ("On the Advancement of Learning", Book II, Section X, 2, 1605.)

Gilbert shared this versatility to an exceptional degree, while yet adorning his profession. In his early days he had given much time to experiments on chemistry, "attaining to great exactness therein"††: this indeed was a natural extension of his work as a physician. He was also an ardent student of astronomy, and the first Englishman to accept and propagate the revolutionary views of Copernicus (1473–1543) and Bruno (1547–1600) on the motions and the nature of the celestial universe.

Medicine, chemistry, astronomy, magnetism and electricity—indeed, his range of studies was wide; and although these sciences (except astronomy) were still in their rudiments, their literature was already great. The invention of printing by movable type, in 1453, had led by Gilbert's time to the appearance of printed copies of the principal ancient authors. Already booksellers had set up their trade in London. Gilbert was doubtless a good customer, eagerly buying and reading the classical, medieval and modern books as they appeared. Most of them, like Gilbert's own book, "de Magnete", were in Latin, either original or translated, thus obviating, for the learned men of that time, the curse of Babel, and making Europe a republic of learning.

To illustrate the wealth of Gilbert's learning, let us note a selection from the authors quoted in "de Magnete":

Among the Greeks, they include the fathers of medicine, Hippocrates (*c.* 430 B.C.)* and Galen (A.D. 131–201); the philosophers Empedocles (*c.* 500–430 B.C.), Plato (427–347 B.C.) and Epicurus (342–270 B.C.); the historian Plutarch (*c.* A.D. 45–120); the astronomers Thales (*c.* 624–565 B.C.), Aristarchus (*c.* 310–230 B.C.), Hipparchus (*c.* 190–120 B.C.) and Ptolemy (*c.* A.D. 170); the mathematicians and scientists Pythagoras (born *c.* 582 B.C.), Anaxagoras (488–428 B.C.), Aristotle (384–322 B.C.) and Hero (*c.* A.D. 100)†. Among the ancient writers of Latin, he quoted Lucretius (*c.* 95–55 B.C.), Pliny (A.D. 23–79), Tacitus (A.D. 55–120) and St. Augustine (A.D. 354–430).

His medieval references include Geber the Syrian (*c.* 850), Rhazes the Persian (865–925), Avicenna of Bokhara (980–1037) and others who wrote in Arabic; Albertus Magnus (1206–1280), Roger Bacon (1214–1294), Thomas Aquinas (1227–1274) and Petrus Peregrinus (whose famous "Epistola" was written in 1269).

Among the moderns, as reckoned in Gilbert's time, he quoted Cardinal Cusa (1401–64), Copernicus (1473–1543), Fracastor (1483–1543), Paracelsus (1493–1541), Agricola (1490–1555), Cardan (1501–76), Fallopius (1513–62), Oviedus (who wrote a "History of the East Indies", 1525), Stevinus (1548–1600), Tycho Brahe** (1546–1601), and three contemporaries, Robert Norman, William Borough and William Barlowe, who wrote on magnetism in English.

These authors were philosophers, physicians, theologians, mathematicians, astronomers, biologists, metallurgists, navigators and historians. Some were quoted only in the astronomical chapter with which "de Magnete" concludes, but most of them had something to say about magnetism. This is not surprising, because in the magnet Nature affords her simplest example of a field of force of notable intensity surrounding objects that are of moderate size, fairly available and widespread, and easy to handle. This was bound to attract notice and comment by writers of all kinds, and to be used by theologians, philosophers and poets as a basis for theories and analogies, by the early physicians as an ingredient of strange potions, and by magicians as a tool to impress the ignorant, as well as by navigators and landsmen in the form of the compass.

Many of those who wrote of the magnet did so only by hearsay, and to the wonderful truth was added a fantastic growth of fable and error, such as that the loadstone's magnetic power was dulled at night; that when weak it is revived if bathed in goat's blood; that it has the power to reconcile husbands to wives, and brides to husbands; and that if pickled in the salt of a sucking fish it gains the power to pick up gold from the deepest wells.

In writing "de Magnete", the first substantial modern scientific treatise, giving a systematic account of magnetism, Gilbert wished to clear away the current errors as well as to establish the truth. He found, in fact, far more to condemn than to retain in his predecessors' writings on magnetism, and he did not scruple to castigate the errors and false theories even of the greatest among them. For example, he says that to the one sole magnetic property, attraction, known to the ancients††, "were added certain fragments and falsehoods: which in the earliest times, no less than nowadays, used to

* Address delivered at a commemorative meeting held by the Royal Society of Medicine on April 5.

† According to the reckoning (which is not certain) of the late Prof. Silvanus Thompson.

** See p. xi of de Mottelay's introduction to his (the first) English translation of "de Magnete". The basis for the mention of eighteen years is presumably Edward Wright's statement, in his 'encomiastic preface' to "de Magnete", that the magnetic philosophy had been "kept back not till the ninth year only (as Horace prescribes) but already unto almost a second nine".

†† Quotation given by de Mottelay, in his introduction, p. xxv; the source is not stated.

* Most of the dates here given are taken from Singer's "A Short History of Science" (Oxford, 1941).

† Though neither Euclid (*c.* 330–260 B.C.) nor Archimedes (287–212 B.C.) were mentioned.

** But Gilbert's other famous astronomical contemporaries Galileo (1564–1642) and Kepler (1571–1630) are *not* mentioned.

†† In this and later quotations from "de Magnete", I follow (almost completely) the English translation published in 1900 for the Gilbert Club, and printed (250 copies only) by the Chiswick Press.

be put forth by raw smatterers and copyists to be swallowed of men. As for instance, that if a loadstone be anointed with garlic, or if a diamond be near, it does not attract iron. Tales of this sort occur in Pliny, and in Ptolemy's *Quadripartitum*; and the errors have been sedulously propagated, and have gained ground (like ill weeds that grow apace) coming down even to our own day, through the writings of a host of men, who, to fill out their volumes to a proper bulk, write and copy out pages upon pages on this, that and the other subject, of which they knew almost nothing of their own experience. Such fables of the loadstone even Georgius Agricola himself, most distinguished in letters, relying on the writings of others, has embodied as actual history in his book *De Natura Fossilium*". ("de Magnete", Book I, Chapter 1.)

"Almost nothing of their own experience," Gilbert here says, and it is the kernel of his criticism. The importance of experiment is expressed with equal clarity and firmness in his comments on the writings of those whom he revered, as in this passage:

"Thomas Aquinas, writing briefly on the loadstone in Chapter VII of his *Physica*, touches not amiss on its nature, and with his divine and clear intellect would have published much more, had he been conversant with magnetic experiments". (Book I, Chapter 1.)

Experiment, where experiment is possible, is the keynote of Gilbert's philosophy; thus, as he says in his preface:

"we have proposed to begin with the common magnetic, stony and iron material, and with magnetical bodies, and with the nearer parts of the earth which we can reach with our hands and perceive with our senses; then to proceed with demonstrable magnetic experiments. . . . For after we had . . . seen and thoroughly examined many of those things which have been obtained from mountain heights or ocean depths, or from the profoundest caverns and from hidden mines: we applied much prolonged labour on investigating the magnetical forces: . . . Nor have we found this our labour idle or unfruitful; since, daily during our experimenting, new and unexpected properties came to light".

This method is now a commonplace of science, but in Gilbert's time ancient authority was the basis of truth for all but a challenging few, like Gilbert and Galileo. Hence Gilbert had no bright anticipations of the reception his book was likely to gain. Why should I, says he:

"expose this noble philosophy, which seems new and incredible by reason of so many things hitherto unrevealed, to be damned and torn to pieces by the malediction of those who are either already sworn to the opinions of other men, or are foolish corrupters of good arts, learned idiots, grammatists, sophists, wranglers, and perverse petty folk". (Preface.)

His appeal was therefore, avowedly, to the few:

"But to you alone, true philosophizers, honest men, who seek knowledge not from books only but from things themselves, have I addressed these magnetical principles in this new sort of philosophizing. But if any see not fit to assent to these self-same opinions and paradoxes, let them nevertheless mark the great array of experiments and discoveries (by which notably every philosophy flourisheth), which have been wrought out and demonstrated by us with many pains and vigils and expenses. In these rejoice, and employ them to better uses if you can". (Preface.)

The need for a much more active and extensive use of the experimental method was urged by Francis Bacon, in his "Advancement of Learning" and other books, published after Gilbert's death, but probably influenced by Gilbert's example. Thus, writing from the point of view of a man of affairs, regarding the steps that needed to be taken to advance learning, after noting that books, maps, globes, astrolabes, botanic gardens, and dead bodies for anatomy were among the needs for which there was already some provision, Bacon says:

"there will hardly be any main proficience in the disclosing of nature, except there be some allowance for expenses about experiments; whether they be experiments appertaining to Vulcanus or Daedalus, furnace or engine, or any other kind. And therefore as secretaries and spials of princes and states bring in bills for intelligence, so you must allow the spials and intelligencers of nature to bring in their bills; or else you shall be ill advertised.

"And if Alexander made such a liberal assignation to Aristotle of treasure for the allowance of hunters, fowlers, fishers and the like, that he might compile an history of nature, much better do they deserve it that travail in arts of nature". ("Advancement", **2**, 10, 11.)

Gilbert, however, paid his own expenses for experiment, and was content to go his own way, in advance of his time. His independence of mind was shown in "de Magnete" and also in other ways. The title page gives *first* his own name, before that of the book. Then comes a preface to the "candid reader", written, as my quotations will have shown, in a proud confident tone. Contrary to the custom then and for two centuries more, he made no dedication to a patron. In this, as in his experimenting, he practised what Bacon afterwards preached but did not practice; for Bacon, in the "Advancement of Learning", addressed, rather fulsomely, to James I, wrote:

"Neither is the modern dedication of books and writings, as to patrons, to be commended: for that books (such as are worthy the name of books) ought to have no patrons but truth and reason. And the ancient custom was to dedicate them only to private and equal friends, or to entitle the books with their names: or if to kings and great persons, it was to some such as the argument of the book was fit and proper for: but these and the like courses may deserve rather reprehension than defence". (Book I, Sect. III, 9.)

Gilbert, indeed, almost reversed the custom of dedication, by publishing, next after* his own preface to the candid reader, an encomiastic preface "To the most eminent and learned man Dr. William Gilbert, a distinguished Doctor of Medicine amongst the Londoners, and Father of Magnetic Philosophy". This was written by Edward Wright (1558 ?–1615), a noted Elizabethan mathematician and teacher of astronomy and navigation.

As a scientific author Gilbert showed many virtues. Though "de Magnete" had no index of subjects or authors, Gilbert included an ample index of chapters (without page numbers). The treatise is divided into six books, comprising 115 chapters, so that the list of chapter titles gives a clear and full indication of

* In de Mottelay's English translation of "de Magnete", the order of the two prefaces is reversed; no reason for this erroneous order is given.

the contents and structure of the book. It is a substantial work containing about 120,000 words, and is well illustrated with ninety woodcuts (not numbered) of diagrams and pictures of loadstones and apparatus. It also contains a glossary of eighteen new scientific terms that Gilbert found it convenient to introduce. The book contains no footnotes, but an interesting innovation was the use of marginal stars, of two sizes, to indicate the discoveries and experiments described, "according to the importance and subtlety of the matter" (Preface); there were twenty-one large stars and two hundred small ones; most though not all of these starred experiments and discoveries were originated by him. This notably individual feature of the book is of great interest as showing Gilbert's estimation of the relative value of his experiments.

## Experimental Work on Magnetism

Gilbert's "de Magnete" made three great contributions to science; the first was the ordering and extension of magnetic knowledge, on the basis of experiments originated or verified by himself. The second was the ordering and extension of electric knowledge, in the same way. The third, and in my opinion the greatest, was his conception of the earth itself as a great magnet.

Gilbert had a great predecessor among writers on magnetism, Petrus Peregrinus, who in 1269 wrote a famous letter to a friend, of which many manuscript copies were made, until it was printed in 1558. In this letter Petrus clearly stated that the loadstone has two unlike poles, and showed how to find and recognize them by means of small auxiliary needles laid on the loadstone. Petrus had a fancy to shape his loadstones spherical, like the earth and the celestial bodies, and to mark on them lines of magnetic direction like meridians joining the two poles. At either pole a small needle will stand perpendicular. One pole seeks the north, and the other the south. Like poles repel, unlike poles attract each other. Iron can be magnetized by the touch or stroke of the loadstone, thus acquiring the loadstone's attractive, repulsive and directive properties. When a loadstone is cut in two, a pair of opposite new poles appears, one on each part, so that each becomes a complete magnet, with two opposite poles.

This letter by Petrus, firmly based on experiment, is a magnificent scientific classic, despite some fallacies of perpetual motion in its second part, of which the author himself seemed doubtful.

Petrus wrongly thought that the magnetic compass pointed to the *true* north. He ascribed this to celestial influences exerted from the whole heavens, not only from the celestial poles; he did not attribute it, as many others did, to the 'nautical' or pole star, for he knew that this was not at the true celestial pole.

After his time, it became known that the magnetic compass does not point to the true north, and gradually knowledge was accumulated about the distribution of this magnetic declination, which varies from place to place. The first discoverers of the magnetic declination are not known.

Then in 1581, Robert Norman, a maker of compasses at Limehouse, discovered the magnetic dip of a magnetized needle perfectly balanced before magnetization. He examined and studied this discovery with great ability; in particular, he concluded from it that the earth, not the sky, controls the direction of the magnet, and he showed that the earth did not *attract* the magnet but only *turned* or directed it.

These were the foundations on which Gilbert built. He mentions Petrus and Norman several times, though more often to condemn their few errors than to praise their great merits. He refers to "a little work, fairly learned for the time, going under the name of one Petrus Peregrinus, which some consider to have originated from the views of Roger Bacon, the Englishman of Oxford" (p. 5): Norman he described as "a skilful seaman and ingenious artificer, who first discovered the dip of the magnetic needle" (p. 8).

Of Gilbert's twenty-one big-star experiments, two were electric and nineteen magnetic; of the two hundred with small stars, twenty-nine were electric and a hundred and seventy-one magnetic.

My time permits only brief mention of even the big-star experiments. Gilbert experimented with loadstones and magnets of many shapes, but like Petrus he specially favoured the spherical form, which he called a terrella. On this, again like Petrus, he marked the lines of magnetic direction from pole to pole; these he named "magnetic meridians". He also marked the "magnetic equator" midway between the poles, and intermediate circles of "magnetic latitude", such as the arctic and tropical. Whereas Petrus he had merely *laid* little magnetic needles on his round loadstone, Gilbert *pivoted* his, each on a little stand, and showed that between the equator, where they lie parallel to the surface, and the poles, where they stand perpendicular, the needles rest inclined. In this he saw a parallel to the magnetic dip on the earth, discovered by Norman; with bold imagination, overstepping an enormous disparity of size, he leapt to the conclusion that the compass needle turns northward, and dips, because to the earth it is what his pivoted needles were to the terrella, and hence that the earth itself is simply a great spherical magnet. To quote his own words (in translation): "The magnetic dip (which is the wonderful turning of magnetic things to the body of the terrella) in systematic course, is seen in clearer light to be the same thing upon the earth. And that single experiment, by a wonderful indication, as with a finger, proclaims the grand magnetic nature of the earth to be innate and diffused through all her inward parts". (Book VI, Chapter 1.) This conclusion, which is the foundation of the science of geomagnetism, has never been seriously contested, though we still do not know *why* the earth is magnetic.

Gilbert's further developments of geomagnetism were not so successful. He ascribed the compass declination, or departure from the true meridian, to the inequalities of the earth's solid surface on land or under the sea, and he concluded that near either coast of a great ocean the needle should turn somewhat landwards. This was disproved nearly a century later by Halley (1656–1742). Further, Gilbert concluded that without cataclysmic changes, such as the submergence of the fabled continent of Atlantis, the magnetic declination at each place must remain for ever constant; this was disproved in 1635 by Gellibrand, a Gresham professor, from fifty years of compass observations in London.

Gilbert, though a great reader and a devoted experimenter, was no recluse. His friends included not only physicians, astronomers and mathematicians, but also sailors, to whom there are many references in "de Magnete"; for example, in Book III, Chapter 1, on the compass direction, he writes that certain facts "have been pointed out to me and confirmed by our most illustrious sea-god, Francis Drake, and by

another circumnavigator of the globe, Thomas Candish". Gilbert hoped that his experiments and discoveries would add to the already great usefulness of the magnetic needle to mariners. The Dutch scientist Stevinus had pointed out that when the distribution of the magnetic *declination* had been well observed in many parts of the earth, it should conversely be a help to mariners (knowing their latitude) in determining their *longitude*; Gilbert shared this hope, though he knew that the distribution was not simple, and he added the new proposal that the magnetic *dip* would enable mariners to find their *latitude* when astronomical observation was impossible. But both these ideas proved fruitless, owing to the irregular distribution of the earth's magnetism, and its constant slow change. Before this became clear, Briggs, the introducer of *common* logarithms (to the base 10), had spent much wasted labour on calculations of the magnetic dip in different latitudes, on the basis of a rather fantastic geometrical construction proposed by Gilbert, with no real foundation either in experiment or theory.

Passing from these, Gilbert's faulty additions to his most brilliant discovery, let us consider briefly his experimental work in pure magnetism and pure electricity. In these he greatly extended the range of substances known to be magnetic or electric. He also distinguished very clearly between magnetic and electric actions, and added many important details, some of them quantitative, to our knowledge of both.

He attained to the conception of what we now call the magnetic field surrounding a magnet, or, in his words, its "orb of virtue". He attained also to the conception of what we call uniform intensity of magnetization, showing that the magnetic influence of a terrella is not something emanating only from the poles, but is an aggregate effect of all its parts. He disproved the asserted anti-magnetic influence of the diamond by assembling no less than seventy excellent diamonds, in the presence of many witnesses, around loadstones and magnets, without any observable magnetic change. (Book III, Chapter 13.)

He found that the magnetization of a body can be destroyed by heating it to redness, but that heated iron, in cooling, acquires a small intensity of magnetization in the north – south direction, from the earth's magnetic field. He observed that soft iron, even without heating, becomes slightly magnetized by the earth's field, either slowly, over many years, or more rapidly if it is hammered while lying north and south. He showed also that a sheet of iron can partly screen the space on one side of it from the magnetic field or action of a loadstone on the other side.

He showed that a magnet could support a much greater weight of iron if soft iron caps were put over its poles.

He improved instruments of magnetic observation, including Norman's dip needle; and he collected data as to the compass direction* in different regions.

## Work on Electricity

Gilbert's work on electricity is given, almost as a digression, in one chapter (Book II, Chapter 2), entitled "On the Attraction of Amber, or more truly, on the Attaching of Bodies to Amber"; this chapter also describes various experiments on what we now know as surface tension. Silvanus Thompson, who was an enthusiastic reviver of Gilbert's memory, summed up his experimental discoveries in electricity as follows:

(1) The generalization of the class of *Electrics*. (2) The observation that damp weather hinders electrification. (3) The generalization that electrified bodies attract everything, including even metals, water and oil. (4) The invention of the non-magnetic versorium or electroscope. (5) The observation that merely warming amber does not electrify it. (6) The recognition of a definite class of non-electrics. (7) The observation that certain electrics do not attract if roasted or burnt. (8) That certain electrics when softened by heat lose their power. (9) That the electric effluvia are stopped by the interposition of a sheet of paper or a piece of linen, or by moist air blown from the mouth. (10) That glowing bodies, such as a live coal, brought near excited amber discharge its power. (11) That the heat of the sun, even when concentrated by a burning mirror, confers no vigour on the amber, but dissipates the effluvia. (12) That sulphur and shell-lac when aflame are not electric. (13) That polish is not essential for an electric. (14) That the electric attracts bodies themselves, not the intervening air. (15) That flame is not attracted. (16) That flame destroys the electrical effluvia. (17) That during south winds and in damp weather, glass and crystal, which collect moisture on their surface, are electrically more interfered with than amber, jet and sulphur, which do not so easily take up moisture on their surfaces. (18) That pure oil does not hinder production of electrification or exercise of attraction. (19) That smoke is electrically attracted, unless too rare. (20) That the attraction by an electric is in a straight line toward it.

Few substantial advances on Gilbert's work in pure magnetism and electricity were made for more than a century. The quantitative laws of magnetic action, sought by Halley in 1687 and later without much success, were first established by Coulomb (1736–1806) by means of his torsion balance (1785). The first notable advance beyond Gilbert in electrical knowledge was made by Otto von Guericke (1602–86), burgomaster of Magdeburg, the inventor of the air pump; he constructed the first electrical machine, namely, a globe of sulphur, which when rotated, while a hand was pressed upon it, became electrically charged. He also showed that there are two kinds of electricity, and that bodies charged with the same kind repel one another, whereas Gilbert knew only of electric *attraction*.

## Astronomy

The last Book (VI) of "de Magnete" is mainly astronomical, and is of great interest for its long serious argument in favour of the Aristarchean and Copernican hypothesis that the earth rotates, rather than that the sun, moon, planets and stars all revolve daily round the earth. Gilbert supplied an additional argument of his own, finding in the geomagnetic axis a real terrestrial feature with which the daily rotation is associated, whereas in the common view the axis of rotation was not terrestrial but celestial. He asserted that the magnetic axis remains invariable in the earth, but that, with the earth, it turns round the pole of the ecliptic, thus causing the precession of the equinoxes. He makes only brief mention of the earth's orbital motion (see "de Magnete", p. 232, Gilbert Club edition, 1900). He seems to attribute the daily and precessional motions partly to the earth's magnetism. Since his day it has become clear

* S. P. Thompson, in "Gilbert of Colchester" (*J. Inst. Elec. Eng.*, 1903), states that Gilbert also collected observations of dip, but I know of no authority for this statement. "de Magnete" appears to contain not one numerical value of the dip, not even quoting Norman's observation of it, in London.

that the geomagnetic axis does not coincide with the earth's axis of rotation, and is not quite constant; we incline nowadays to attribute the earth's magnetism partly to its rotation, rather than vice versa. Newton later showed that the precessional motion of the earth's axis is due to gravitational and dynamic causes, independent of geomagnetism.

Despite his advanced philosophic outlook, Gilbert was not free from the then prevailing belief that the stars influence mundane affairs (Book VI, Chapter 8). He believed that just as "Nature has taken care, through the earth's soul or magnetic vigour", to incline its axis to the pole of the ecliptic, so that the orbital motion produces the succession of the seasons, so also "the stars shift their rays of light at the surface of the earth through this wonderful magnetical inflection" (or precession) of the earth's axis. "Hence", he said, "come new varieties of the seasons of the year, and lands become more fruitful or more barren; hence the characters and manners of nations are changed; kingdoms and laws are altered, in accordance with the virtues of the fixed stars as they culminate, and the strength thence received or lost in accordance with the singular and specific nature of each. . . ."

Gilbert's interest in astronomy was shown by his authorship of a second considerable treatise, left in manuscript at his death, and not published until by the care of a brother it was printed in Amsterdam in 1651. Its title, translated from the Latin original, was "On our Sublunary World, a New Philosophy". Though it contains several references to "de Magnete", it made no further contributions to magnetism. It expounded the then revolutionary astronomical views of Bruno, whom it cites, and is largely an anti-Aristotelian discussion on astronomy, meteorology and the tides.

Gilbert did not live long enough after the appearance of his masterpiece, "de Magnete", to learn fully whether its reception was better than he had pictured in his preface. On the whole it was well received, though the astronomical part was disclaimed by some who accepted the magnetic discoveries; among these were Gilbert's friend Barlowe, and also the Jesuits, by whom the last Book (VI) was regarded as heretical. But greater men, including Gilbert's younger contemporaries Kepler and Galileo, wrote of "de Magnete" with high praise. This judgment has been endorsed by posterity, and as the centuries have rolled on, the fame of Gilbert has stood firm, as a great pioneer of magnetic and electric experiment, and as the father of the sciences of geomagnetism and electricity.

# WILLIAM GILBERT: HIS PLACE IN THE MEDICAL WORLD*

By SIR WALTER LANGDON-BROWN

FULLER'S "Worthies" has a charming account of William Gilbert. He did not know him personally, for Gilbert had been dead five years when Fuller was born. But he had talked to people who had known him. This prompted him to write as follows: "William Gilbert was born in Trinity Passage in Colchester, his father being a Counsellour of great Esteem in his Profession, who first removed his family thither from Clare in Suffolk, where they had resided in a gentile Equipage some Centuries of Years. He had (saith my informer) the clearness of Venice glass without the Brittleness thereof, soon ripe and Long Lasting in his Perfections. He commenced Doctor in Physick, and was Physician to Queen Elizabeth who stamped on him many Marks of her favour, besides an Annual Pension to encourage his Studies. He addicted himself to Chemistry attaining to great exactness therein. One saith of him that he was Stoicall, but not Cynicall, which I understand; Reserv'd but not Morose, never married, purposely to be more beneficial to his Brethren. Such was his loyalty to the Queen that as if unwilling to survive, he dyed in the same year with her 1603. His stature was Tall, Complexion Cheerful, an Happiness not ordinary in so hard a Student and Retired a Person. He lyeth buried in Trinity Church in Colchester under a plain Monument. Mahomet's tomb at Mecca is said strangely to hang up, attracted by some invisible Loadstone; but the Memory of this Doctor will never fall to the ground, which his incomparable book 'de Magnete' will support to Eternity."

It is difficult to enlarge this admirable miniature without spoiling it. Also it is difficult to make use of Silvanus Thompson's excellent account of Gilbert without shameless plagiarism. This was written for the tercentenary of Gilbert's death celebrated at Colchester in 1903. Mr. Puryer White, of St. John's College, kindly lent me the copy belonging to the late Sir Robert Scott, formerly Master of the College, which is enriched with notes by the Master's hand, drawn from the College records concerning Gilbert's career. From these it is clear that he matriculated in May 1558. If the commonly accepted date for Gilbert's birth of 1540 is correct, this would make him eighteen when he entered, which would be rather old for those days. Hence, doubts have arisen, and dates ranging from 1540 to 1544 have been given; hence also, our justification for celebrating the quatercentenary of his birth in 1944. After graduation he was elected to a fellowship, his name being spelled Gylbert on the roll. Here again, we meet with a discrepancy in the record. Sir Robert Scott states that he was admitted on Sympson's foundation, but Bass Mallinger, a former learned if eccentric librarian and historian of the College, states "Fisher's statutes of 1530 had relieved all 'physic fellows' from the obligation of taking orders, but the statutes of 1545 had limited such exemptions to two, a proviso which continued in force until 1860. Notwithstanding this restriction, however, the sixteenth century saw three successive Presidents [of the Royal College of Physicians] elected from such 'physic fellows' of St. John's. These were—Richard Smith 1585; William Baronsdale 1589, and the eminent William Gilbert 1600. The last representative of this group was Dr. Henry Thompson, Consulting Physician to the Middlesex Hospital, who died in 1897." The present Master of St. John's College, Mr. E. A. Benians, tells me that the list of distinguished physicians who studied there in the sixteenth century was due to Bishop Fisher's insistence on encouraging the study of Greek in the College, which, despite Erasmus, encountered opposition elsewhere; and on Greek the revival of medicine was believed to be based from Linacre onwards.

The probable explanation of the apparent discrepancy is that Gilbert was elected in the ordinary way, but as he did not take orders, had to become 'physic fellow' or resign his fellowship within the stated time.

* Address delivered at a commemorative meeting held by the Royal Society of Medicine on April 5.

After taking his M.A., Gilbert acted as examiner in mathematics, and in 1569 became senior bursar at St. John's. In the same year, he was admitted M.D. and was senior fellow. In the next year he terminated his twelve years of residence in college and went abroad, travelling in Italy for three years. Not much is known of this, but from his writings it would appear that he drew inspiration from such medical men as Cardan, Fallopius and Frascatorio. He had a great repugnance to the teachings of Paracelsus and Albertus Magnus, and scoffed at Arnoldus de Villanova of Salerno. In 1573 he returned to England, as Silvanus Thompson says, "a pronounced hater of shams and quackery, a champion of the experimental method and an outspoken enemy of all those who merely relied on the authority of great names".

He did not return to Cambridge, but having been elected a fellow of the Royal College of Physicians, settled in London in Wingfield House on St. Peter's Hill, which ran from St. Paul's churchyard to Upper Thames Street, crossing what is now Queen Victoria Street just to the east of the College of Heralds. Thus he was close to the first College of Physicians, which had been Linacre's own house. Here he formed a learned society which met at his house, and they laid before Queen Elizabeth a scheme for the foundation of an Academy of Natural Philosophy which was to have been a real University of London. Nothing came of it, and the "Invisible College" did not arise for about half a century. Thus Gilbert stimulated experimental science in Britain before all Bacon's theoretical contributions to the subject. Bacon indeed repeatedly refers to him with respect in the "Novum Organum" and elsewhere.

His success in practice was rapid. In 1577 he was granted arms, which are now carved in relief in the North Court of St. John's College. From 1581 until 1590 he was a censor, and from 1587 until 1592, treasurer of the College of Physicians. He served a second term as treasurer from 1597 until his election to the presidential chair. In the year of the Armada he was one of four physicians to inquire into an epidemic that had broken out in the Royal Navy. Lancelot Browne, William Harvey's father-in-law, was another, while a third was Wilkinson, who preceded Harvey as physician to St. Bartholomew's Hospital. Gilbert had many professional associations with Lancelot Browne, who succeeded him as president of the College; considering this and the family tie between Browne and Harvey, it seems probable that the latter learned something of Gilbert's outlook. This may have been the source of information for Harvey's statement that Gilbert spent £5,000 on his researches—a large sum in those days.

In 1589 the College of Physicians decided to compile a Pharmacopœia, and Gilbert was on the committee for carrying this out. Its publication was, however, delayed until 1618. On this Silvanus Thompson remarks: "If it had appeared in his lifetime, he would not have sanctioned the inclusion of Emplastrum divinum of Nicholaus, consisting of powdered loadstone made up with wax, oil, litharge and various spices, for in *de Magnete* he had denounced the prescription in unsparing terms as an evil and deadly 'recommendation of an abominable imposture' ". For, as Gilbert said, "It is when whole that the loadstone draws. . . . The application of a loadstone for all sorts of headaches no more cures them (as some make out) than would an iron helmet or a steel cap." On the positive side, he was a great believer in iron as a fine powder steeped in the "sharpest vinegar" and dried, for the treatment of anæmia. He said that "it restores young girls when pallid, sickly and lacking colour, to health and beauty". He also advised iron for enlarged spleen; Hale White suggests that malaria then being very common in England, the patients improved because it benefited the accompanying anæmia. He was very sarcastic about many ridiculous claims made for remedies, saying: "Thus do the smatterers cross swords together and puzzle inquiring minds by their vain conjectures".

Dr. Charles Singer suggests that Gilbert's interest in experimental science was aroused by meeting Giordano Bruno who was in England during 1583–85, at Elizabeth's court, probably in the company of Sir Philip Sidney. But Gilbert did not become a Court physician until the year after Bruno's martyrdom, and that he did not frequent the Court much before is indicated by the dismay shown by his little group of scientific friends who met at his house on St. Peter's Hill when he was appointed physician to the Queen. They feared, and as the event proved, justifiably, that the removal to Whitehall would break up their coterie, and their researches would languish. Still, it is quite possible, considering the fashionable nature of Gilbert's practice, that he would have known Sir Philip Sidney and have met Bruno, even if not at Court. As evidence of the kind of practice he had, we find the Earl of Shrewsbury writing of him to a friend, [he is] "a sensible man; therefore seek to be acquainted with him and be very friendly of him". Then again, in January 1597, Gilbert attended Lady Cecil at Hatfield in her last illness. An unpleasant incident occurred during his visit; one of her jewels was missing and a Robert Wisson (or Weston) was charged with the theft. He was in attendance on Gilbert nominally as his servant, but it would appear he was probably Gilbert's nephew! However, all must have ended well, for we find Gilbert attending Lord Burghley on his death-bed a year later.

Gilbert retained his association with his native town of Colchester by the possession of the family residence of Tymperleys in Trinity Street after his stepmother's death in 1589. He resided there occasionally and became one of Colchester's leading citizens, though it is not known whether he practised there. He was always proud of his association with Colchester, and styled himself "Colcestiensis" on the title page of his great book.

In 1600 Richard Hakluyt published the third and last volume of his "Voyages", and in the dedication to Sir Robert Cecil he stated: "I was once minded to have added to the end of these my labours a short treatise which I have lying by in writing, touching 'The curing of hot diseases incident to travelers in long and Southerne voyages', which was written in English, no doubt of a very honest mind by one M. George Wateson. . . . But being carefull to do nothing herein rashly I showed it my worshipfull friend M. doctor Gilbert, a gentleman no lesse excellent in the chiefest secrets of the Mathematicks (as that rare Jewel lately set fourth by him in Latine doth evidently declare) than in his own profession of physicke; who assured me, after hee had perused the said treatise that it was very defective and imperfect and that if hee might have leisure, which that argument would require, he would either write something thereof more advisedly himselfe or would conferre with the whole College of the Physicians,

and set downe some order by common consent for the preservation of her Majesties subjects". But this scheme he never carried out. Mr. Benians kindly lent me a facsimile copy of this treatise edited by Dr. Singer. It is certainly "very defective and imperfect" though it contains some interesting references to treatment by liver for intestinal disorders (Did he encounter sprue, one wonders ?), to the value of fresh and not salted meat for scurvy, and most interesting of all, to his use of a strong infusion of pepper ? For it was not until less than twenty years ago that the richness of pepper in vitamin C was demonstrated.

Dr. Singer identifies the author with George Whetstone, the poet and swashbuckler who in 1578 wrote a crude play, "Promos and Cassandra", the original of Shakespeare's "Measure for Measure". From 1587 he disappeared from sight until the publication of this treatise in 1598, and it is fair to assume that it was during this interval that he went on the voyages which provided the material for his ideas on tropical and marine diseases.

On the death of Dr. James, Gilbert became, as already stated, physician to Queen Elizabeth; the patent gives his salary as £100 a year. He does not appear to have accompanied her on her many tours through the country, by which she spared her own pocket and conferred distinction on so many bedrooms. Her Court physicians seem to have been expected to give her New Year presents and we find that on the last new year she lived to see, Gilbert's gift was "one pott of Orange flowers and another of green ginger", while in return he received 13¾ oz. of gilt plate, so he did not do so badly on the exchange. He must have had some trying times with her, for in her latter days much success had brought with it many illusions; and as Ben Jonson remarked to Drummond of Hawthornden, "she never saw herself after she became old in a true glass". The temperament thus displayed led to terrible scenes in her last illness, in which Gilbert attended her. The description is well known. "She alternated between fits of rage and periods of silence and stupor. She railed at her physicians and her counsellors, refusing food, refusing physic, and refusing even to rest. Shortly before the end, she sat obstinately on her cushions outside her chamber, in spite of all the endeavours of ladies of the bed chamber to induce her to go to bed".

In the British Museum there is a long roll upon which Camden, the herald, has drawn in ink a representation of the funeral procession of the Queen. In this is a group of four men walking together, labelled Clerks of Parliament and Doctors of Physic. One of these, with pointed beard, ruff and hat, as in the engraved portrait of Gilbert by Clamp, leaves little doubt as to identity.

It has been repeatedly stated that Queen Elizabeth left Gilbert a pension and that he was the only man mentioned in her will. Silvanus Thompson points out that as she is not known to have left a will, the granting of a pension must remain in doubt.

Gilbert was appointed physician to James I, but did not live long enough to enjoy that office as he died on November 30 O.S., 1603. As Silvanus Thompson speaks of this being his sixtieth year, he evidently accepts the date of his birth as 1544. It would seem likely that he died of plague, which we know was then rife. The best account of the epidemic will be found in Thomas Dekker's book, "The Wonderful Yeare 1603, showing London lying Sicke of the Plague". "Every house," he says, "lookt like St. Bartholomew's Hospital." Many that "would have been glad of a bed in an hospitall, and dying in the open fields have been buried like dogs. . . . Never let any man ask me what became of our physitians in this massacre—they hid their synodicall heads as well as the prowdest. Galen could do no more than Sir Giles Goosecap"; and so on in the approved euphuistic mode. But Gilbert neither fled nor hid himself. Michael Hicks, who had been secretary to Queen Elizabeth, wrote to the Earl of Shrewsbury thus: "I heard as I was writing here of that Dr. Gilbert the physician is dead who was my neighbour at St. Peter's Hill. He was a learned physician and an honest. The sickness is greatly diminished in London, and the citizens do return in great numbers". The association between these two sentences points to plague as the cause of death.

Gilbert lived a bachelor and died a wealthy man. Besides money, he bequeathed to the College of Physicians his library, globes, instruments and cabinet of minerals; but all these were lost in the Great Fire of London except a few folio volumes, which cannot now be identified.

In 1904, the year after the Colchester celebration of the tercentenary of Gilbert's death, an interesting document was discovered bearing his autograph and seal. Owing to Mr. Puryer White's kindness, I can tell the whole story from the records of St. John's College. Dr. Fenn having succeeded to the ownership of Alston Court, Nayland, found therein boxes of old documents. Among them was a power of attorney executed by Gilbert in favour of Robert Middleton, his attorney. The ink in some parts had eaten its way through the paper, leaving the words like charred stencils in the thin, yet finely made paper. He communicated his discovery to his cousin, G. D. Liveing of St. John's. Apparently the house at Nayland had belonged to their great-grandfather, who had been executor to Thomas Bayles, whose forbears had succeeded to Middleton's practice at Colchester. The witness to the document was Gilbert's brother, Ambrose, who founded two scholarships at St. John's. The value of the document is enhanced by the rarity of William Gilbert's autograph, only two others being known—one on a medical certificate addressed to Lord Walsingham, now in the Record Office, the other discovered by Silvanus Thompson in a book which belonged to Gilbert when at St. John's; also by the fact that it is sealed with Gilbert's own signet ring, carrying his crest, a half-eagle with wings displayed. Prof. Liveing, in communicating the discovery to the College, makes this interesting comment. "The spelling of ordinary English words had not crystallized in Elizabeth's reign, much less that of names, and it was certainly [so] common at that time to spell the same name in two or more different ways in one document that I have concluded that it was done purposely so that nothing might turn on the spelling to invalidate it". Colchester has always pertinaciously adhered to the spelling Gilberd, and as it appears thus at the head of this document, the city is apparently justified.

It may be of interest to look for a moment at the background of Gilbert's life in Cambridge and London. In both, active changes were occurring. At the universities, and particularly at Cambridge, the concentrated interest in theology which had formed the main study of scholasticism was declining. The active developments in the State were making a demand for the sons of the gentry to play their part in the social

system of the country and its government. So they went to the university to acquire some general culture. There was a risk that the new enthusiasm for deeper study and research "would be elbowed out of existence by endeavours to gratify the wish for a higher education which would suit a young gentleman desirous of making his mark in some recognized public or professional capacity and which should not take up too much of his time". This risk was materially increased by the introduction of a system by which school and college elections were influenced in favour of the well-to-do against the poor; more especially the best prizes—fellowships—were awarded in obedience to mandates obtained in devious ways from the Court. For the first time a university education had a social value, which led to a different type of student and a more riotous way of living. So much so that Caius, who had done his best to promote the new learning, began to wonder whether his benefactions had been wisely bestowed. It is, by the way, curious that though Caius and Gilbert were contemporaries at Cambridge, separated only by the length of Trinity Street, there is no record of any association between them. It strengthens my expressed belief that Caius was more interested in institutions than in individuals. We can set against this an undoubted spread of a genuine love of learning, while the following century was the most active in the intellectual life of Cambridge until the latter half of the nineteenth. Still, one must admit that in the Elizabethan period there was a change from a home for poor scholars to a more mundane life—a change which has in varying degrees persisted and which this century has been trying to overcome. There is indeed a danger of the pendulum swinging too far the other way.

As to the position of the medical world at that time, A. W. Ward says, "The physician's profession . . . was being disentangled on the one hand from that of the clergyman . . . and on the other hand from the trade of the apothecary . . . and from that of the barber, who united to his main function those of the dentist, and yet others. . . . The pretensions of both physicians and surgeons to a knowledge of which they fell far short were still a subject of severe censure; but little or nothing was said in or outside the profession against what was still the chief impediment to the progress of medical science—its intimate association with astrology".

On these dangers, both at the university and in the medical profession, Gilbert's influence was salutary. His insistence on observation and experiment, his scorn for reliance on mere authority, his hatred for shams and quackery, were not without their effect. In the conditions laid down for the teacher of medicine in the Academy he visualized, but which never came to fruition, it was stated, "He was never to allege any medicine of any kind, but that he was to declare the reason philosophical of every particular, and he was to show how the medicine was made and all the instruments used in making it. . . . The physitian was continually to practise with the Natural Philosopher to try and search out the riddles of Nature." Note here an anticipation of Harvey's injunction. Gilbert has been called the first English Copernican, and without transgressing beyond my particular thesis of Gilbert as a physician, I would urge that this made him particularly suited to combat the pestilential influence of astrology on medicine, from which Jean Fernel of Paris was just emancipating himself.

"Q." has spoken of "men, who with the splendour of the Renaissance in their eyes, supposed themselves to be working all the while upon pale and borrowed shadows". Thus Linacre looked to the past for the revival of learning; Caius faced both ways; but Gilbert steadfastly looked forward, and thus he may be acclaimed the first of English modern men of science, and was so recognized by the succeeding generation. For Sir Thomas Browne described him as the Father Philosopher who discovered more in terrestrial magnetism than Columbus or Amerigo ever did by it, while Dryden said of him, "Gilbert shall live till Loadstones cease to draw".

REFERENCES

Hale-White, Sir Wm., "Bacon, Gilbert and Harvey" (London, 1927).

Moore, Sir Norman, Wm. Gilbert, "Dictionary of National Biography".

Munk, Wm., "The Roll of the Royal College of Physicians", Vol. 1 (London, 1878).

Thompson, Silvanus P., "Gilbert: Physician" (Chiswick Press, 1903).

## CEREAL DISEASES

### By W. C. MOORE

THE important place of cereals in the war-time food production programme, and the urgency of increasing both acreages and yields, have inevitably thrown into prominence the problems of failure and loss through disease. A good deal of attention has been given to these problems during the war years, and the time is appropriate to take stock of the position. For this purpose the Association of Applied Biologists recently devoted one of its general meetings to a symposium on cereal diseases, which was held at the Imperial College of Science and Technology, with the president, Prof. W. Brown, in the chair.

In his introductory remarks Mr. W. C. Moore referred to the surveys of plant diseases organized by the Ministry of Agriculture and Fisheries since 1917. These enable one to form a fairly clear picture of the relative importance of different cereal diseases; but the time is now ripe for concerted efforts to determine the significance of disease more precisely and in terms of loss of yield or in cash value. More than fifty diseases have been listed on cereals in England and Wales, and of these at least seven are of some economic importance—wheat bunt (*Tilletia caries*), take-all (*Ophiobolus graminis* and its var. *Avenae*), eyespot (*Cercosporella herpotrichoides*), yellow rust (*Puccinia glumarum*), mildew (*Erysiphe graminis*), leaf spot of oats (*Helminthosporium Avenae*) and leaf stripe of barley (*Helminthosporium gramineum*). To these must probably be added the various deficiency diseases about which little is yet known. Yellow rust is the most injurious of cereal rusts, but only about once in ten years is it sufficiently bad (as in 1943) to reduce yields by more than an estimated 5–10 per cent. Black rust is usually late and local; but occasionally, probably when large numbers of uredospores are blown over from the Continent in June or July, an epidemic such as occurred in 1940 develops. Bunt bids fair to repeat its behaviour after the War of 1914–18 unless care is taken. In the early '20's about a third of the seed wheat samples were bunted. A steady improvement followed, and in 1940 the figure was as low as 1·2 per cent; but the number of badly bunted crops reported in the last three years strongly suggests that the disease may again be on the increase, in spite of the great advances made in seed dressing. Fortunately, ergot

need give rise to no alarm in Britain. It becomes prominent only when cool, wet weather prolongs the normally short flowering period, and these conditions have been fulfilled very few times in the last twenty-five years.

Those who have not personally studied biologic specialization in fungi are often bewildered by, or even sceptical of, the multiplicity of physiologic races found among rust fungi. All modern British work on biologic specialization in cereal rusts has been carried out under the supervision of Prof. F. T. Brooks, and the authoritative survey he made of the subject was both illuminating and stimulating. The races of each rust are determined by their behaviour on a limited number of differential host varieties in the seedling stage when grown under constant environmental conditions. The complexity of the problem is exemplified by the fact that nearly two hundred physiologic races of *Puccinia graminis tritici* and more than a hundred of *P. triticina* have been defined abroad, chiefly in the United States. Nothing is known about the particular races of *P. graminis tritici* that occur in Britain, but a number have been distinguished in *P. triticina*, *P. anomala* and *P. coronata*. At least two races of yellow rust are found here, and a comprehensive survey for further races is needed after the War in order that the relative susceptibility of common wheat varieties to them can be determined. Certain difficulties are inherent in the work. Genetic purity of the differential races and of the rust cultures is essential, the cultures must be kept in isolation and free from contamination, and constant environmental conditions must be maintained. In view of the extreme biologic specialization in cereal rusts and the possibilities of further changes by hybridization and gene mutation, Prof. Brooks doubts whether further study along the usual lines will be really profitable except in relation to plant-breeding programmes. To the plant breeder the discovery of physiologic specialization is of paramount importance. He need not concern himself with all the races described, for many of them behave as single groups in the field; moreover, the discovery of mature plant resistance has greatly eased matters. None the less, new virulent races may develop at any time, and the position can be safeguarded only by continued close co-operation between pathologists and plant breeders.

Dr. W. A. R. Dillon Weston reviewed the history of cereal diseases in East Anglia during the past twenty-one years and explained how their prevalence and intensity have been influenced by improvements in seed treatment. In 1923 copper sulphate was the chief material used for disinfecting seed wheat against bunt. A few farmers used formalin, and afterwards copper carbonate came into prominence for a time, but in the early '30's these were gradually displaced by the organo-mercury seed dressings. This was an event of outstanding importance. The new compounds provided an effective means of controlling the stripe diseases of barley and oats, which had up to then been responsible for much pre-emergence blight and thin stands. As a result the balance has gradually shifted; leaf blotch of barley (*Rhynchosporium Secalis*), for example, which is not seed-borne and therefore not prevented by seed treatment, has become more noticeable as the prevalence and intensity of leaf stripe has declined. Oat smut, at one time prevalent and intense in most crops, is now less evident. On the other hand, the most recent trials with various organo-mercury dusts have shown that they are not all equally effective, and this aspect of things was considered in its relation to the voluntary scheme, recently inaugurated by the Ministry of Agriculture and the Department of Agriculture for Scotland, for the official approval of insecticides and fungicides marketed under brand names for the control of plant pests and diseases. Particular emphasis was laid on the need to assess the efficiency of the products by field tests. Cereal rusts are not normally serious in East Anglia, and take-all, at one time rampant on many farms, cannot now be considered a major problem.

Dr. R. W. G. Dennis discussed the occurrence of cereal diseases in Scotland, where the position is somewhat different from that in England and Wales. Oats are the most important cereal crop, and the seedling blight phase of leaf spot is still the most important disease—in 1942 more than half of 260 samples of seed taken at random showed from 5–42 per cent infection with Helminthosporium. Tribute was paid to the pioneer work of D. G. O'Brien, whose efforts to put dry seed dressing on its feet in west Scotland had resulted in the sale in 1932 of sufficient organo-mercury dust to dress two million bushels of grain or about half the oats sown in Scotland that year. The use of seed dressings is now general in the west and to some extent in the north, but on the best Lothian soils and elsewhere in the east little benefit is derived from their use, even with heavily infected grain. Species of Fusarium, especially *F. nivale*, and pre-emergence rotting due to soil fungi are also responsible for thin stands of oats sown under poor moist conditions or in wet soils. The virtual disappearance of oat smuts in Scotland occurred before seed dressings came into use and has been attributed to the introduction of 'regenerated strains' of oat varieties and to increased care and selection of seed crops. In the wetter districts of the west and north take-all is prevalent in oats following old pasture and is common elsewhere if oats are taken more than two years in succession. Crown rust is usually scarce, though extensive outbreaks occur at long intervals. Wheat diseases are of little importance apart from eyespot, which is widespread in the Lothians, Fife and Morayshire; bunt is scarcely ever seen and brown rust (*Puccinia triticina*) is unknown in Scotland.

Take-all of wheat is widely distributed in England, but becomes troublesome only in wet seasons and on light soils overlying chalk or limestone, where the rotation is too short. The form on oats is restricted to those areas—Wales, the north-west and north of England, and Scotland—where oats is the chief cereal crop. Mr. S. D. Garrett, whose work on this disease has thrown so much light on the wider and more fundamental problems of root rot caused by fungi, discussed the factors affecting the behaviour of take-all in different soils and seasons. Growth of the runner hyphæ of Ophiobolus along the host roots is favoured by good soil aeration and by an alkaline reaction of the soil. In poorly aerated or acid soils the growth of the hyphæ may be controlled by accumulation of respiratory carbon dioxide at the root surface, with which is associated a reduction in the partial pressure of oxygen. In well-aerated soils carbon dioxide must diffuse rapidly away from the root zone, and in alkaline soils a high proportion of the carbon dioxide is transformed into bicarbonate. Light-textured soils also favour take-all inasmuch as they are usually poor in nitrogen and often other plant nutrients, and deficiency in the

main nutrients hinders recovery from attack by curtailing the production of new secondary roots to replace those destroyed by the fungus. In Australia phosphate is usually the missing nutrient, in England nitrogen. The exceptional severity of the disease in certain southern counties of England in 1942 may have been due in part to leaching-out of nitrates by abnormally heavy rainfall in January. Survival of Ophiobolus in infected root and stubble residues is mainly dependent on an adequate supply of nitrogen from the soil, which encourages fresh hyphal growth.

For some years Miss M. D. Glynne has made a special study of eyespot in wheat and barley, and the account she gave of this disease revealed how closely it is bound up with lodging in these crops. Less eyespot occurs on light, well-drained soils than on heavy, wet ones, and the climate of the west and north of Britain favours attack by it more than conditions in the south and east. Yet, because oats are highly resistant and the disease increases with the frequency of wheat and barley in the rotation, eyespot is more prevalent in the eastern than the western half of southern England. In a thin crop the individual affected straws begin to fall over among the upright ones from the end of June, giving the condition known as 'straggling'. If the affected crop is a heavy one general lodging is likely to take place sooner or later in long-strawed varieties. In a survey carried out in 1941, lodging caused by eyespot was about as common as lodging due to non-parasitic causes. In addition to direct loss from the disease there may be indirect loss as a result of lodging. Experimental work has shown that in a field with about 60 per cent severe infection, yield is reduced by 30 per cent and there is a marked increase in the amount of tail corn; if lodging occurs the loss is much greater or even complete. Such losses can be minimized by sound rotation or by using short-strawed varieties and feeding them well.

Dr. F. R. Immer, professor of genetics in the University of Minnesota, was warmly welcomed as a visitor at the meeting, and in the general discussion that followed he referred briefly to the programme for plant breeding in relation to disease that is now under way in Minnesota. He expressed surprise at the wide differences in cereal disease problems in Britain and the United States; but entered a word of warning against underestimating the real effect and the potentialities of common but apparently harmless diseases.

# NEWS and VIEWS

## Research Fellowships at British Universities

THE directors of Imperial Chemical Industries, Ltd., have offered to provide eighty fellowships at nine universities in Great Britain, to be held by senior workers in certain sciences. The scheme is announced to operate for an initial period of seven years, and the fellowships will be of the average value of £600 a year, though the universities will have power to determine the emolument for each particular appointment. The subjects to which the fellowships are to be devoted are laid down as physics, chemistry and the sciences dependent thereon, including chemotherapy. The administration of the scheme rests wholly with the universities, which will select and appoint the fellows, subject only to such conditions as to duties and tenure as the universities themselves impose. No conditions whatever are attached by I.C.I. to the tenure of these fellowships. The fellows will be members of the university staffs, and will be concerned only with the duties laid upon them by the universities. Their primary work will lie in research; but they must also take some part in university teaching. It is intended not to relieve the universities from the cost of maintaining any part of their normal work, but to enable them to add to what they already do. The universities to which this offer has been made comprise the larger metropolitan universities and those which have a close geographical relation to the main centres of the Company's production. Twelve fellowships have been offered to the Universities of Oxford, Cambridge and London, eight to the Universities of Glasgow, Edinburgh, Manchester, Birmingham and Liverpool and four to the University of Durham.

The purpose of the directors of Imperial Chemical Industries, Ltd., in instituting this scheme is to strengthen the general provision in British universities for scientific teaching and research. It is intended to implement the Company's view that academic and industrial research are interdependent and complementary, and that substantial advances in industry cannot be looked for without corresponding advances in academic science; and the main purpose is the strengthening of university scientific departments in whatever way each university thinks to be best. A rational policy of this character, together with a wise selection of men both as regards capabilities and tenure of office, will lead, it is thought, to the emergence of a body of men capable of taking high academic or industrial positions, thereby advancing academic and industrial research. This it should certainly accomplish, for the scheme is so wide in its scope, and the universities are given so free a hand in its working, that most of the limitations usually inherent in trusts and endowments are avoided. The task is now before the selected universities, while preserving scrupulously their independence, so to select recipients of these fellowships as to justify the belief in the importance of university research which has led to their establishment.

## The Society for Cultural Relations

THE Society for Cultural Relations between the Peoples of the British Commonwealth and the U.S.S.R., known more widely by its briefer title S.C.R., has just completed its first twenty years of activity and has issued a concise and very interesting report on its work during the period. It is difficult now to recapture the atmosphere of 1924, when the sufferings caused by the Revolution and the Civil War were still fresh in people's minds, and only relatively few recognized the importance of trying to understand what was going on in Russia and of breaking down the barriers that threatened to isolate that country from the Western world. A small but distinguished group of people founded the Society and organized an exhibition of Soviet art, books and

magazines; a Science Section was formed under the chairmanship of Sir Richard Gregory and a Press Committee of British and Russian journalists met. Later, various other sections were formed and the Society steadily increased in membership. Each year has seen new developments, and since the War both the status and the influence of the Society have been heightened; it has been recognized that only by keeping exclusively to the one purpose of fostering cultural relations can the Society hope to make a wide appeal. It now has a good library and a panel of lecturers, and it is prepared to deal with inquiries coming within its ambit. We wish the Society continued success in the important and difficult tasks that will confront it in the post-war years.

## Indian Famine Inquiry

THE Government of India has announced the following names of the chairman and members of the famine inquiry commission: Sir John Woodhead, Finance Member of the Government of Bengal 1932–1937, Governor of Bengal during June–November, 1939 (chairman); Mr. S. V. Ramamurti, adviser to the Governor of Madras and formerly director of agriculture, Madras; Dr. W. R. Aykroyd, director of the Nutritional Research Laboratory, Coonoor; Khan Bahadur Mien Afzal Hussain, formerly principal of the Agricultural College, Lyallpur; Sir Manilal B. Nanavati, president of the Indian Society of Agricultural Economics, deputy governor of the Reserve Bank of India during 1936–1941, and an authority on sociological and agricultural problems; Mr. R. A. Gopalaswami (secretary), assisted by Rai Bahadur D. N. Maitra.

## Higher School Certificate Biology

THE content and form of the traditional syllabus for the Higher School Certificate examination are frequently influenced by the older point of view that biology, botany and zoology are intellectual disciplines unrelated to ordinary life, and, further, that anything relating to human beings lies in the province of anatomy and physiology in the medical curriculum. Modern opinion is that such studies are closely interwoven with our own lives and that, while they may serve as an introduction to subsequent professional or university courses, they should also form, because of their method and content, an essential part of the education of the ordinary citizen. Some progress has been made in this direction by slight emendations or re-interpretations of existing syllabuses; but a Joint Advisory Committee for Biology was set up by the University of Cambridge in June 1943 to recast thoroughly the syllabuses for the Cambridge Local and Oxford and Cambridge Schools examinations. The Committee included representatives of the teaching profession and of the University of Cambridge, and also had the advice of one of H.M. inspectors of secondary schools, members of the University of Oxford, the Matriculation and School Examinations Council of the University of London, and the Central Welsh Board.

The resulting syllabuses, quite new in content and outlook, are not regarded as definitive, but criticisms are invited and it is proposed to issue a revised edition if, when they have been given a trial, it is found that modifications are necessary. The syllabus of each subject is fully set out and, in zoology, detailed notes explaining the intention of the various parts of the syllabus are provided. The content is arranged for a course extending over two school years and assumes that 450 periods each of forty minutes are available. A useful feature of the report is that each subdivision of a subject is followed by a suggestion of the approximate number of periods that should be devoted to it. These suggestions, if followed in a reasonable and not slavish manner, should result in a well-balanced course without overweighting particular parts and at the same time allow latitude for individual circumstances. In the opinion of the writer of this note the syllabuses are a welcome improvement on most of those at present in effect and decidedly a move in the right direction, particularly if more attention is given to the individual practical work of the pupils: but—the proof of the pudding is in the eating. Copies of the report can be obtained from the Cambridge University Press, 200, Euston Road, London, N.W.1, price 6*d*. (7*d*. including postage).

## Apprenticeship and the New Education Bill

SOME strong criticisms of the raising of the school-leaving age envisaged under the new Education Bill are given in a recent pamphlet on "Apprenticeship for a Skilled Trade" by Mr. F. Twyman, managing director of the well-known optical firm of Messrs. Adam Hilger, Ltd. (London: Charles Griffin and Co., Ltd. 5*s*. net). Thus he says, "Besides tending towards the disappearance of skilled craftsmen and arresting the development of individual boys, the proposed deferment of the school-leaving age will lessen the productive capacity of the nation just at a time when it should be increased". Mr. Twyman speaks in no uncertain terms against the views of those who seem to regard it as self-evident that, schooling being a good thing, the longer it is continued the better; and he claims that there is a general neglect of the fact that at the age of fourteen many normal boys become impatient of learning unless they see some useful result. He believes that the skilled trades can best be satisfactorily recruited through a scheme of apprenticeship commencing at fourteen years of age under which boys would enter the trade with part-time day release to attend school, varying from two days a week at fourteen to one day at eighteen years of age. The scheme would be based upon the following four main premises: (1) industry needs more good craftsmen; (2) these can only be attained by apprenticeship; (3) the apprenticeship contract must embody a curriculum; (4) independent inspection must be provided to ensure that the terms of the contract are fulfilled.

There is good sense in much of what Mr. Twyman says about the need for realism in modern education, and he would probably be surprised to find that a large number of educationists agree with him; indeed, his proposed scheme of apprenticeship is essentially educational in character, since the young apprentice, instead of wasting his early years in making tea and running errands, would from the start learn practical subjects in the works under strict supervision. Mr. Twyman's essay certainly suggests a valuable scheme for co-operation between school and industry, which should fittingly be examined at the present time.

## Bureau of American Ethnology

IN spite of its increasing concern with the war effort, the Bureau of American Ethnology still manages to carry out some of its normal activities (Sixtieth Annual Report: June 1942 to June 1943.

Pp. 10. Washington: Gov. Printing Office). Although the general policy is not to undertake field work during the War, special circumstances made it advisable to make a preliminary investigation of a site in the Agate Basin, East Wyoming. This yielded points of general Yuma character, but of relatively recent date. Dr. Stirling, chief of the Bureau, took charge of a further National Geographic Society – Smithsonian Institution Expedition to southern Mexico, which continued excavations at La Venta. Publication continued, and it is good to hear that the great "Handbook of South American Indians" is three-quarters complete. Three bulletins were issued, and eight were in the press at the end of the year. Members of the staff were active in promoting inter-American co-operation, and with this end in view the Inter-American Society of Anthropology and Geography was formed. A quarterly journal, *Acta Americana*, is to be issued. Specifically war-like activities comprised the preparation of various Smithsonian Institution War Background Studies and publications of the Ethnogeographic Board, besides the answering of numerous questions from the armed forces.

## Ophthalmological Research at Leeds

On the recommendation of a special committee, the Council of the University of Leeds has adopted a scheme for the establishment of an Ophthalmological Research Centre. As soon as the necessary funds are available, the Council will proceed to the appointment of research fellows to work on special problems concerned with the prevention and cure of blindness and other diseases of the eye. X-ray equipment, the recently installed electron microscope and other facilities will be made available for the work in the University. The maintenance and development of the Centre will be in the hands of an Ophthalmological Research Advisory Committee.

## Officers and Trustees of Science Service

The following have been re-elected officers of Science Service, the American institution for the popularization and interpretation of science: president, Dr. E. G. Conklin; vice-president and chairman of the Executive Committee, Dr. Harlow Shapley; treasurer, O. W. Riegel; secretary, Watson Davis. Dr. Otis W. Caldwell, of the Boyce Thompson Institute for Plant Research and general secretary of the American Association for the Advancement of Science, and Max B. Cook, promotion editor of Scripps-Howard newspapers, have been elected to the Board of Trustees, which is now constituted as follows, the bodies represented by the trustee being indicated in brackets: Dr. Otis W. Caldwell, Dr. Edwin G. Conklin, president of the American Philosophical Society, and Dr. Henry B. Ward, University of Illinois (American Association for the Advancement of Science); Dr. Warren H. Lewis, Wistar Institute of Anatomy and Biology, Dr. R. A. Millikan, California Institute of Technology, and Dr. Harlow Shapley, director of the Harvard College Observatory (National Academy of Sciences); Dr. C. G. Abbot, secretary of the Smithsonian Institution, Dr. Ross G. Harrison, chairman of the National Research Council, and Prof. Hugh S. Taylor, Princeton University (National Research Council); A. H. Kirchhofer, managing editor of the *Buffalo Evening News*, O. W. Riegel, Washington and Lee School of Journalism, now on war leave with the Office of War Information, and Neil H. Swanson, executive editor of *Sun* papers (journalistic profession); Max B. Cook, Frank R. Ford, editor, Evansville Press, and H. L. Smithton, executive agent of the E. W. Scripps Trust (E. W. Scripps Estate).

## Night Sky in August

Full moon occurs on August 4d. 12h. 39m. U.T., and new moon on August 18d. 20h. 25m. The following conjunctions with the moon take place: Aug. 14d. 20h., Saturn 1° N.; Aug. 20d. 03h., Venus 2° S.; Aug. 20d. 19h., Mercury 8° S.; Aug. 21d. 04h., Mars 4° S. In addition to the above, the following conjunctions also take place: Aug. 13d. 13h., Venus in conjunction with Jupiter, Venus 0·6° N.; Aug. 26d. 15h., Mercury in conjunction with Venus, Mercury 6·1° S. Mercury reaches its greatest eastern elongation on Aug. 10. The planet sets at 20h. 38m., 19h. 51m. and 18h. 38m. at the beginning, middle and end of the month respectively. Venus is too close to the sun to be favourably observed, setting about half an hour after sunset during the month. Mars, Jupiter and Saturn are not well placed for observation, though Saturn is becoming visible in the early morning hours, rising about midnight towards the middle of the month. The Perseid meteors reach their maximum on Aug. 10–12.

## Announcements

At a meeting of the Council of the Institute of Fuel, held this month, it was announced that Dr. E. W. Smith has agreed to continue in office as president for a further period of twelve months, that is, until October 1945. It was also announced that the Melchett Medal for 1944 has been awarded to Dr. J. G. King, director of the Gas Research Board, in recognition of the outstanding work he has done in recent years during his long connexion with the Fuel Research Station at Greenwich; and that Mr. H. L. Pirie, one of the honorary secretaries of the Institute of Fuel since its inception, has been made an honorary member.

The following have been elected officers of the Institution of Electrical Engineers for the session 1944–45: *President*, Sir Harry Railing; *Vice-President*, W. J. H. Wood; *Honorary Treasurer*, E. S. Byng; *New Members of Council*, H. Bishop, W. N. C. Clinch, F. C. Winfield, and Dr. R. W. Sillars.

The Chadwick Trustees are offering an award of £250 for an investigation of the reasonable maximum 'density' range (per acre) for small houses with gardens, suitable especially for the intermediate and outer zones of large towns—with due regard to the amenities essential to a comprehensive town planning arrangement. Applications, in writing, must reach the Clerk to the Chadwick Trustees, 204 Abbey House, Westminster, London, S.W.1, before the end of September, accompanied by evidence of qualifications and a brief statement of the general plan of research proposed.

Referring to the review in *Nature* of March 18, p. 327, of "Frontiers in Cytochemistry", the editor, Prof. Normand L. Hoerr, has pointed out that he was incorrectly described as the successor of Prof. R. R. Bensley in the chair of anatomy in the University of Chicago; Prof. Hoerr is professor of anatomy at Western Reserve University, Cleveland, Ohio.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Marine Biological Research in Great Britain

THE coast-line of Great Britain offers an unrivalled diversity of habitats for the study of marine benthic communities. There is a considerable proportion of rocky shore, including the peculiar facies provided by the chalk of southern England; there are many stretches of sand and shingle and numerous inlets affording specialized habitats of diverse kinds. Can it be said that we are playing our part in the biological exploration of the numerous communities thus available to us? Speaking as a botanist, I would answer this question in the negative.

Apart from the valuable work of Lloyd Williams, Margery Knight and Kathleen Drew, the great advances in our knowledge of the structure and reproduction of seaweeds during the last thirty years are almost entirely due to the activities of Danish, French, German and Swedish workers. On the taxonomic side, also, Great Britain has made no serious contribution, comparable to the monumental work of Sauvageau on Sphacelariales or to Kolderup Rosenvinge's important memoir on the Rhodophyceæ of Denmark. I am not qualified to say how far these criticisms apply also to the benthic fauna.

It is true that a considerable number of papers dealing with the general floristic composition of the benthic communities of seaweeds on various parts of the coast of Britain has been published. One may recognize the value of the preliminary data thus obtained; but it may be doubted whether this work has materially added to our understanding of the nature and composition of these communities, since the publication of Cotton's outstanding memoir on the marine Algæ of Clare Island in 1912. Certain of the papers published during the last twenty years have been concerned with the effects of diverse environmental factors, in particular those affecting the littoral communities. More important advances in these directions have, however, been made by Continental workers.

Much of the floristic work is rendered less valuable by the complete or almost complete absence of data regarding diatoms, which play an important part in many littoral and sublittoral communities. Little information is available as to their time of occurrence and distribution, or the part that they almost certainly sometimes play as colonizers. Moreover, the communities occurring near and above high-water mark have usually been but imperfectly studied, despite the biological interest attached to the specialized conditions of their habitat. The only detailed investigation of such communities, so far as I am aware, is that of Anand on those inhabiting the chalk cliffs of southern England. Greater progress has been made with studies on the floristic composition and conditions of existence of the algal flora of salt-marshes, thanks to the excellent work of Sarah Baker and Nellie Carter.

The interrelations of fauna and flora in the benthic zone are subjects of great biological interest. An approach to this aspect of marine ecology has been made by a number of workers in Great Britain, more particularly by zoologists. In the absence of evidence of assistance from a competent algal taxonomist one may feel some degree of diffidence in accepting as complete or altogether reliable the data offered on the floristic side; moreover, as with the purely floristic studies, diatoms are in general left out of the picture. In any event these investigations have scarcely got beyond the fringe of the problems involved. Attention may also be directed to the need for a more comprehensive study of British marine fungal parasites than has hitherto been undertaken.

For the most part the diverse researches referred to above have been carried out by biologists working in universities remote from the site of their investigations. The latter have been effected by means of periodical visits, and all credit must be given for the more or less successful surmounting of the difficulties that are inherent in discontinuous work of this nature. No real progress is, however, to be expected until far better facilities than those at present existing become available. In particular, it is essential that a lead to the investigation of the benthic flora and fauna of the sea be given by an established group of workers, permanently in touch with the problems and expert in special aspects of marine biology. The investigation of the ecological problems that await solution demands a team of workers which should include one or more zoologists, as well as at least two botanists specializing respectively in seaweeds and marine diatoms. Afterwards, one or more physiologists will have to join the team to aid in the solution of the diverse problems relating to growth, nutrition, etc., that will arise. Once such a centre had been firmly established, its activities would rapidly expand by the attraction of research workers from the universities.

It is natural to look to the Laboratory of the Marine Biological Association at Plymouth as the best centre for the development of such work. The very high reputation of this Laboratory and of the members of its staff would encourage the performance of work at a high level of achievement. So far, however, the fundamental research carried on there has been directed in the main to investigations dealing with the pelagic life of the sea, research which has led to results of outstanding scientific importance. If the Plymouth Laboratory is to undertake also the investigation of the marine benthos, a courageous policy will be necessary. To restrict unduly the number of workers detailed for this aspect of marine biological investigation or to limit the necessary facilities would cramp the work at the outset and as likely as not result in failure. In view of its bearings on the elucidation of general biological principles and its possible economic importance, it may not be looked upon as a mere appendage of the work hitherto carried on at Plymouth.

Should other considerations not render feasible such an extension of the scope of the work of the Plymouth Laboratory, it would be better to concentrate research on marine benthic plants and animals at an altogether separate centre. For such a purpose one of the other marine stations already in existence or one of the maritime universities can be envisaged. Alternatively, since it is to be hoped that similar centres may be established in one or more parts of the Empire, especially in the tropical zone, the University of London might appropriately consider the foundation of such a station.

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# Self-recovery in Metals

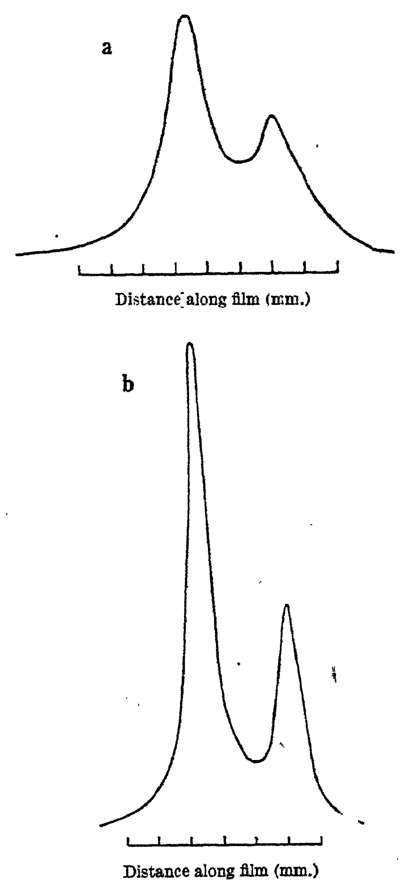
Two theories have been put forward to account for the broadening of the X-ray reflexions given by cold-worked metals. First, the crystals may be broken down into small mosaic elements (fragmentation)[1], or, secondly, they may be so distorted by the stresses (microstresses) present that the lattice parameter varies over a range of values[2]. Recent work seems to indicate definitely that in the case of copper[3], tungsten and α-brass[4] the major part of the broadening is due to the latter effect.

Although it would seem reasonable to extend these results to all metals, a difficulty arises in the case of those such as aluminium which give sharp lines when cold-worked. On the fragmentation theory this would correspond to an unusually large value of the limiting crystallite size; on this account it has been claimed[5] that aluminium is 'self-recovering' at room temperature, the implication being that after cold-working the crystal grains increase so much in size that the broadening they produce is negligible. The microstress theory, however, cannot produce such a ready explanation; at first sight it would seem necessary to assume that no appreciable stresses were present in the cold-worked metal, and this is not in agreement with the known mechanical properties.

Some contribution towards the solution of this problem has been given by the observations of Wilson[6] and Spillett[7] that the broadening of the X-ray lines given by cold-worked aluminium sheet is not negligible. We have verified that this is also true for filings; the accompanying figure shows photometer curves, derived from photographs taken in a 19 cm. diameter camera, for line 420 for unannealed and annealed filings, and it will be seen that there is a considerable difference between the two although the α-doublet is clearly resolved in each case.

It only remains to show that the broadening is of a reasonable order of magnitude. In order to do this, we have compared it with the broadenings given by several other cold-worked cubic metals, and have derived the corresponding value of the internal stress $T$ in each case. We have used the relation $T = E\beta\cot\theta/4R$, where $E$ is Young's modulus, $\beta$ is the measured broadening, $\theta$ is the Bragg angle and $R$ is the radius of the camera. $E$ depends on the indexes of reflexion, but for the present purpose it may be considered as a constant.

| Metal | Indexes of reflexion | Radiation | $\beta\cot\theta$ (mm.) | $T$ | Ultimate tensile stress |
|---|---|---|---|---|---|
| | $h\ k\ l$ | | | $10^8$ dynes/cm.$^2$ | |
| Iron | 2 1 1 | Iron $K\alpha$ | 1·11 | 58·7 | 30–80 |
| | 2 2 0 | | 1·12 | | |
| Nickel | 3 3 1 | Copper $K\alpha$ | 0·97 | 53·2 | 35–120 |
| | 4 2 0 | | 0·96 | | |
| Copper | 3 3 1 | Copper $K\alpha$ | 0·64 | 23·5 | 23–47 |
| | 4 2 0 | | 0·79 | | |
| Silver | 3 3 1 | Cobalt $K\alpha$ | 1·06 | 22·2 | 23–36 |
| | 4 2 0 | | 1·11 | | |
| Aluminium | 3 3 1 | Cobalt $K\alpha$ | 0·15 | 3·0 | 6 |
| | 4 2 0 | | 0·17 | | |
| Lead | 5 3 1 | Nickel $K\alpha$ | 0·20 | 0·7 | 1·2–2·1 |
| | 4 2 2 | Iron $K\alpha$ | 0·16 | | |




PHOTOMETER CURVE OF THE 420 LINE FROM (a) FILED ALUMINIUM, (b) ANNEALED ALUMINIUM, WITH COBALT $K\alpha$ RADIATION. THE SCALES FOR ORDINATES OF THE CURVES HAVE BEEN CHOSEN SO AS TO MAKE THE AREAS EQUAL.

The accompanying table shows the values of $T$ for silver, copper, nickel, iron, aluminium and lead, and for comparison are given the values of the ultimate tensile stress for these metals[8]. It will be seen that in each case the two are of the same order of magnitude. Even for lead, which is also supposed to be 'self-recovering' at room temperature, there is a broadening of the X-ray lines of about the right amount.

It does not follow from these results that recovery does not occur in these metals at room temperature; this can be decided only by photographs taken at different times after filing. We have taken such photographs of the metal specimens described above, with the following results.

(a) Iron and nickel showed no appreciable change over several weeks.

(b) Copper and silver showed quite striking changes; the diffraction broadenings decreased to about half their original values, the α-doublet becoming quite clearly resolved. The change in copper occurred over an interval of about a week and we have followed these changes in detail; but the only data we have about silver are that the X-ray lines were sharper after an interval of several months.

(c) Aluminium and lead also showed some change, but in these cases the broadening is so near the limit of experimental error that the effect is not so clear as for silver and copper.

These results cannot be taken as applying to metal in forms other than filings; X-ray photographs of a piece of hammered copper wire, for example, showed little change after several weeks at room temperature.

We hope to publish elsewhere a more detailed account of this work.

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[1] Wood, *J. Sci. Instrum.*, **18**, 153 (1941); *Nature*, **151**, 585 (1943).
[2] Brindley, *Proc. Phys. Soc.*, **52**, 117 (1940).
[3] Stokes, Pascoe and Lipson, *Nature*, **151**, 137 (1943).
[4] Smith and Stickley, *Phys. Rev.*, **64**, 191 (1943).
[5] Wood, *Proc. Roy. Soc.*, A, **172**, 231 (1939).
[6] *Proc. Phys. Soc.*, **54**, 487 (1942).
[7] *J. Inst. Metals*, **69**, 149 (1943).
[8] "Handbook of Chemistry and Physics" (Chemical Rubber Publishing Co., Cleveland, Ohio, 24th edition, 1940), pp. 1656–61.

## Energy of Viscosity as a Measure of the Cohesion of Liquids

THE viscosity of a liquid can usually be represented by

$$\eta = A.e^{E_{\text{visc.}}/RT},$$

where $\eta$ is the viscosity; $A$ is a constant; $E_{\text{visc.}}$ is the energy of viscosity; $R$ is the gas constant; $T$ is the absolute temperature. In connexion with other work, it was deduced that the energy of viscosity should equal the work of cohesion for unassociated and non-metallic liquids. The work of cohesion has been defined by Harkins[1] as the energy required to form a surface in a liquid and is equal to twice the surface energy. Now if both the energy of viscosity and the work of cohesion are expressed as calories per mole, they are nearly equal for unassociated liquids.

| At 20° C. Substance | $E_{\text{visc.}}$ cal./mole | Work of cohesion cal./mole |
|---|---|---|
| *n*-octane | 2,040 | 1,928 |
| *n*-hexane | 1,815 | 1,920 |
| Benzene | 2,515 | 2,322 |
| Acetone | 1,668 | 1,676 |
| Carbon tetrachloride | 2,510 | 2,290 |
| 1,2 dibromoethane | 2,790 | 3,056 |
| 1,2 dichloroethane | 2,320 | 2,394 |

For associated and some polar substances the energy of viscosity is greater than the cohesional work. The factor connecting the two quantities varies between 1·5 and 3·5.

| At 20° C. Substance | $E_{\text{visc.}}$ cal./mole | Work of cohesion cal./mole |
|---|---|---|
| Methyl chloride | 1,592 | 948 |
| Methyl alcohol | 2,475 | 1,076 |
| Ethyl alcohol | 3,290 | 1,380 |
| *n*-propyl alcohol | 4,390 | 1,610 |
| Water | 4,150 | 2,020 |

The values of $E_{\text{visc.}}$ were obtained by graphical differentiation of the ln $\eta$ versus $1/T$ curves, while the work of cohesion was calculated as twice the surface energy of one mole occupying the surface according to the equation:

$$E_s = 2{\cdot}39 \times 10^{-8}.\gamma.V^{2/3}.N^{1/3},$$

where $E_s$ is the surface energy in calories per mole; $\gamma$ is the surface tension in dynes per cm.; $V$ is the molar volume; $N$ is Avogadro's number.

Now if the energy of viscosity equals the work of cohesion, it should be proportional to the energy of attraction between molecules. According to prevailing views[2], the attraction between non-polar molecules is inversely proportional mainly to the sixth power of the distance separating the molecular centres. The attraction between polar molecules is said to be inversely proportional to the third power of that distance. The relationship between $E_{\text{visc.}}$ and the distance between the molecular centres was tested by plotting log $E_{\text{visc.}}$ against log $1/r$, where $r$ is the separation of the molecular centres and can approximately be deduced from the molar volume. The slope of the curve of log $E_{\text{visc.}}$ v. log $1/r$ should have a value of 6 for non-polar substances and a value of 3 for polar substances. *n*-Pentane gave a value for the slope of approximately 5·52; 1,2 dibromoethane a value of 5·75; carbon tetrachloride a value of 6·03. On the other hand, methyl chloride, which is a polar substance, gave a slope of 2·89.

Thus $E_{\text{visc.}}$, the energy of viscosity, equals the work of cohesion in the case of unassociated substances and is quite generally a measure of the attraction between molecules.

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[1] Harkins *et al.*, *J. Amer. Chem. Soc.*, **43**, 35 (1921).
[2] London, *Trans. Farad. Soc.*, **33**, 8 (1937).

## Existence of Time-Dependence for Interfacial Tension of Solutions

IT has been known for some time[1,2] that the surface tension (air–liquid boundary) of aqueous solutions of long-chain compounds decreases slowly over a period of many days before an equilibrium value is reached. This slow decrease cannot be attributed to diffusion of the solute to the surface, for with the usual values of the diffusion coefficient the calculated time of the change should be a very small fraction (about $10^{-7}$–$10^{-9}$) of the observed time[1,3]. With a solute in the aqueous phase, adsorbed at an oil/water boundary, the interfacial tension has been found to reach its equilibrium without a time-lag[3], and it has been commonly assumed that interfacial tension (as distinct from surface tension) is not subject to this slow change.

We have measured interfacial tensions at the interface between water and solutions in hexane of long-chain amphipathic substances. Experiments by a precision drop-weight method[4] showed that the interfacial tension varied with time. The variation has been studied by means of measurements made by the pendent-drop method[5], which allows continuous readings to be made without disturbing the surface.

The interfacial tension has been found to fall, rapidly at first and then more slowly, reaching an equilibrium value after some days. This fall is much slower than can be explained by diffusion to the surface. With lauric acid as the solute, a diffusion

coefficient as low as $10^{-22}$ cm.$^2$ sec.$^{-1}$ would be required, instead of the actual value of about $10^{-5}$ cm.$^2$ sec.$^{-1}$. The diffusion to the surface is therefore followed by a process of high activation energy to produce the final state of the surface film. In confirmation of this, the rate at which the final interfacial tension is reached has been found to increase sharply with rising temperature.

The presence of electrolytes in the aqueous phase has been found to alter the interfacial tension – time variation. With this system, where the electrolyte is in a different phase from the surface-active solute, it can exert a direct influence on the interface without altering the diffusion-rate, degree of aggregation, etc., of the solute in the oil phase.

By expanding and contracting the pendent drop, the closeness of packing of the molecules adsorbed at the interface could be varied and $F$–$A$ curves obtained. The interfacial films behaved like insoluble surface films, since a compression of the film did not drive molecules back into solution. Therefore the activation barrier affects desorption as well as adsorption of molecules.

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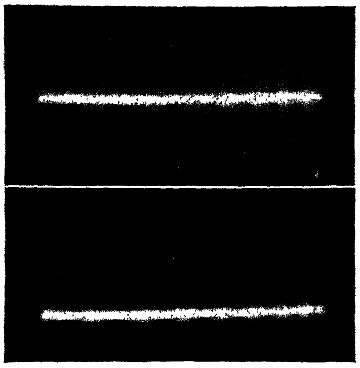
June 22.

[1] Doss, K. S. G., *Koll. Z.*, **84**, 138 (1938) and **86**, 205 (1939).
[2] Adam, N. K., and Shute, H. L., *Trans. Farad. Soc.*, **34**, 758 (1938).
[3] Alexander, A. E., *Trans. Farad. Soc.*, **37**, 15 (1941).
[4] Ward, A. F. H., and Tordai, L., *J. Sci. Instrum.*, to appear shortly.
[5] Andreas, J. M., Hauser, E. A., and Tucker, W. B., *J. Phys. Chem.*, **42**, 1001 (1938).

## Light-Effect in Chlorine under Electrical Discharge: Change of the Wave Form due to Irradiation

Previous work on this phenomenon[1,2,3] showed that a current decrease $\Delta i$ is produced by irradiation of chlorine and other gases referred to the rectified mean r.m.s. values of $i$ under different conditions; changes in the corresponding current-structure and its time-delineation are revealed by a cathode ray oscillograph[3]. An iron core step-down transformer was introduced in series with an A.C. indicator. Its secondaries were connected to one pair of the deflecting plates in the oscillograph; the other pair was connected to the time-sweep potential. With but a moderate amplifier gain on each of the plate pairs and the usual adjustments, the oscillograph revealed, besides the frequency of the A.C. supply, a remarkably large number of higher frequencies of widely varying strengths; they were not transients but repeatable and characteristic constituents of $i$ the discharge current. It was also striking to observe the sensibly instantaneous and reversible diminution of the amplitudes of these component frequencies, on irradiating the discharge tube, as shown by a typical pair of oscillograms reproduced herewith.



Exposure, 2 min.

It was observed[1,4] that the production of a change under electrical discharge, chemical or otherwise, for example, the hydrogen chlorine reaction, the activation of nitrogen, its deactivation, etc., requires a minimum threshold potential $V_m$ characteristic of the reaction, its operative conditions such as the frequency $n$, the temperature, etc. At $V_m$, the wattage dissipated in the system and $i$ show a rapid rise as $V$ is increased. In elementary gases, $V_m$ may be identified with or related simply to the corresponding Paschen potential. Below $V_m$, the oscillograph showed a markedly simple current-structure; further, changes of the amplitudes due to the light-effect were not detected. It is considered that ionization by collision in fields due to the applied potential is a necessary condition for the occurrence of this phenomenon. It is found that both for the light-effect and the above type of reactions, $V_m$ diminishes as $n$ is increased; its influence on the light-effect expressed as $\Delta i/i$ is also in the same direction.

An examination of a number of oscillogram pairs like those reproduced, obtained under different conditions, showed that the proportionate reduction on irradiation of the component amplitudes was fairly uniform. These higher frequencies in $i$ represented both the audio and radio ranges. When the latter were eliminated with a series of H.F. filters, the light-effect in the residual audio range was similar to that for the total or unfiltered current. That the above remark applies also to the radio range was indicated by similar results for the light-effect $\Delta i/i$ observed, with and without an amplifier, for $i$ picked up by a moderate size aerial 1–9 ft. distant from the chlorine tube.

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Benares Hindu University.
May 8.

[1] Joshi, *Curr. Sci.*, **8**, 548 (1939).
[2] Joshi, Pres. Address, Chem. Sec., Ind. Sci. Cong. (1943).
[3] Joshi, *Benares Hindu Univ. J.*, **8**, 99 (1943).
[4] Joshi, *Trans. Farad. Soc.*, **25**, 120 (1929).

## Lanosterol

The problem of the origin and chemical nature of lanosterol—the characteristic substance so far observed only in the wool-grease of the sheep—was originally solved by classifying it as a sterol. Recent evidence[1,2] indicates a more probable connexion with the tri-cyclic terpenes such as α-elemolic acid and with the minor yeast sterol cryptosterol.

Among the oxidation products of cryptosterol are a number of ketonic derivatives which are yellow in colour, probably due to the presence of a chromophore grouping such as $-CO-C=C-CO-$. Ruzicka[3] has lately obtained similar yellow compounds, for example, acetyl-*iso*-elemendionol acid ester, from the

elemolic acids. In continuation of our work on lanosterol[4], we have also isolated a series of yellow ketonic products by the oxidation of lanosterol and its esters with ozone, and with chromic acid. These derivatives include a diketo-alcohol, $C_{30}H_{46}O_3$, m.p. 145°, the corresponding triketone, $C_{30}H_{44}O_3$, m.p. 110° and a compound $C_{27}H_{40}O_4$, m.p. 203°, of which an account will shortly be published.

The formation of these compounds further supports the relationships mentioned, and if the connexion of lanosterol with the tri-terpenes is established, the production, by animal metabolism, of a structural type characteristic of the plant world will provide a problem of biochemical interest.

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J. F. McGHIE.

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London, S.W.1.
June 16.

[1] Bilham and Kon, *J. Chem. Soc.*, 545 (1942).
[2] Wieland and Joost, *Annalen*, **546**, 103 (1941).
[3] Ruzicka, *Helv. Chim. Acta*, **26**, 1651 (1943).
[4] Dorée *et al.*, *J. Chem. Soc.*, 1562 (1936); 172 and 176 (1941).

## Mitochondrial Origin of Cytosiderin (Iron Pigment) in the Liver of Human Pellagrins

DURING the past fifty or sixty years, attempts to reconcile the massive accumulation of iron in various cells and tissues in the body with altered hæmoglobin has led to the universal adoption of the terms 'hæmo-siderosis' and 'hæmochromatosis'. This terminology has focused attention on the metabolism of hæmoglobin and its derivatives, to the exclusion of the consideration of other potential sources of this iron pigment. However, in hæmochromatosis, almost all investigators are agreed that there is no evidence of increased blood destruction to account for the intracellular iron pigment.

By using an improved liver biopsy method, we have studied the liver at the time of admission and during therapy of seventy-six non-European pellagrins, of whom twenty-one were children less than seven years of age and fifty-five adolescents or adults. To date, two hundred biopsies have been performed without any fatalities.

The excellence of the biopsy material allowed us to perform numerous cytochemical studies. In every single liver of the adult and adolescent pellagrins, we noticed, *inter alia*, masses of iron-containing pigment at one stage or another while the cases were under observation. In fact, we regard iron pigment in the liver cell as a constant feature of pellagra in adults, but in children thus far it has not been found under the age of nine years.

The iron pigment arises within the liver cell, appearing first in a region located between the nucleus and the biliary pole of the cell, and corresponding to the position occupied by the Golgi apparatus. Since the pigment arises within the cell, we have named it 'cytosiderin' to distinguish it from the iron pigment derived from hæmoglobin.

By a modification of techniques, we demonstrated simultaneously iron-containing pigment and Sharlach-staining fat in one section, and iron, fat and mitochondria in another. Using such ideal preparations, we felt reasonably certain that the granules of cytosiderin developed from mitochondria which passed through a lipoprotein stage to form combined and free iron. In this transformation the pigment undergoes a series of colour changes from reddish orange to brown or black. All these differently coloured granules contain iron which can be clearly demonstrated by a modified Prussian blue reaction. There is also a reciprocal relationship between the amount of cytosiderin and mitochondria in the cell.

Cytosiderin may be deposited in the liver cells during therapy and may disappear later, or it may be formed in such amounts that the affected liver cell is filled to capacity, disintegrates and liberates its pigment into the sinusoids. Much of it is carried by the Kupffer cells and other histiocytes. The cytosiderin is carried to the portal tracts, and when there is extensive hepatic cytosiderosis, the lymph glands in the porta hepatis and neighbouring regions assume a deep brown colour. With the progress of this disease the portal tracts become thickened, leading ultimately to typical pigment cirrhosis.

We have observed in the same pellagrous patient the complete evolution of pigment cirrhosis from a diffusely fatty liver.

While there is no sexual difference in the incidence of cytosiderosis pigment, cirrhosis is much more common in males.

The demonstration by us that iron pigment may be liberated from intracellular elements, and that cytosiderin may accumulate to such an extent as to lead to pigment cirrhosis, justifies the acceptance of our suggested nomenclature of cytosiderosis as a substitute for hæmochromatosis.

Quite apart from this significant association of cytosiderosis and pellagra, the intimate relationship between fat, cytosiderin, and mitochondria is especially noteworthy. Further studies of these cytoplasmic elements in nutritional deficiencies associated with fatty or cirrhotic livers may lead to a more precise appreciation of the sites of action within the cell of some of the amino-acids, lipotropes and vitamins.

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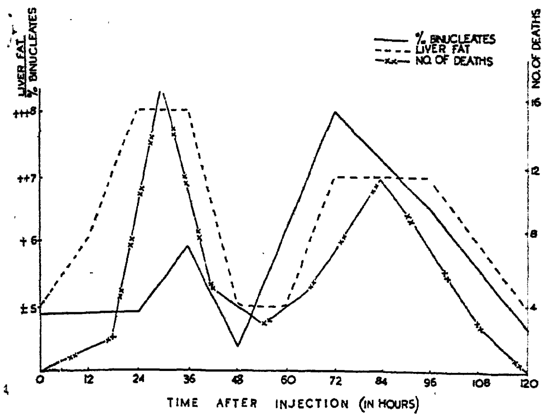
May 26.

## Rhythmic Changes in the Rat Produced by a Single Injection of Chloroform

DURING the progress of an investigation into the effects of various toxic drugs on the cytology and histology of the liver, it was found that after a single injection of a sub-lethal dose of chloroform (0·5 c.c. of 10 per cent solution of chloroform in liquid paraffin) into male rats, the Scharlach R stainable fat in the liver appeared and disappeared in a rhythmic fashion.

Appearing within 12 hours after the injection, the fat gradually increased to reach a very marked concentration between 24–36 hours. Thereafter it rapidly disappeared, falling to a minimum at 48 hours. Little fat was to be seen during the next 12 hours, but between 72 and 96 hours fat was again very abundant, and then disappeared once more. Moreover, the incidence of binucleated cells in the livers increased and decreased together with the fat,




GRAPH SHOWING VARIATIONS IN LIVER FAT, NUMBER OF BINUCLEATED CELLS AND INCIDENCE OF DEATH AFTER A SINGLE INJECTION OF CHLOROFORM.

so that a corresponding binucleate rhythm was obtained.

An identical fat rhythm was also observed in the kidneys of these animals, whereas in the adrenals a rhythm was again found[1], but in this case the fat concentration varied inversely with that in the liver and kidney. Thus peaks in the fat content of liver and kidney corresponded with minimal amounts of fat in the adrenals.

A similar rhythm was observed in guinea pigs. While working on the guinea pigs, it was noted that animals fatally poisoned (4 c.c. of 20 per cent solution of chloroform in liquid paraffin) usually died within 24–36 or 72–96 hours after treatment. Thus of fifty guinea pigs injected with this dose, seventeen died within 24–36 hours, twelve within 72–96 hours and eighteen died either between 36–72 or 96–120 hours; that is, 58 per cent of animals died either within 24–36 or 72–96 hours, 6 per cent survived and the remaining 36 per cent were distributed over all the other intervals giving a U-shaped distribution curve (see graph).

In connexion with these periods of maximum death-rate, it is important to note that Heyd[2], in an analysis of fatalities following biliary tract surgery in man, noted that acute hepatic deaths occurred either 18–36 hours or 4–7 days after operation.

It thus transpires that in response to certain types of injuries there is a rhythmical reactivity involving at least the liver, kidneys and adrenals, in rats, guinea pigs and probably in man. After chloroform poisoning in guinea pigs and rats, this reactivity expresses itself, so far as the liver is concerned, as rhythmic changes in the amount of fat and the number of binucleated cells. There are two distinct periods in this rhythm which are indicated by maximal fat in the liver and kidney, minimal fat in the adrenal and a rise in liver binucleates.

At these periods after the injection of a single dose of chloroform the resistance of the animal is at a minimum, and death is most likely to supervene.

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April 12.

[1] Goldberg, Sylvia, personal communication.
[2] Heyd, C. G., *J. Amer. Med. Assoc.*, **121**, 736 (1943).

## 'Fluorine-like' Action of Various Substances on the Teeth

IT has recently been reported that various substances besides fluorine are capable of producing altered incremental lines in the dentin of rats' incisor teeth. Weinmann[1] has shown that strontium, injected as strontium chloride, will cause a hypercalcified line in the dentin forming at the time of injection; the effects on enamel formation were much slighter. Wessinger and Weinmann[2] have further shown that manganese and boron have similar effects on both dentin and enamel.

In a previous communication[3], I showed that fluorine would produce an incremental calcified line in the predentin of rats on diets with a low calcium–phosphorus ratio. In a further paper[4], this effect was analysed and it was pointed out that this procedure might form a simple method of testing the effects of other substances on tooth calcification. Certain other substances have now been examined both on rats on normal ratio diets (Ca : P = 1·46) and also on diets with a low ratio diet (Ca : P = 0·27).

Young animals on the normal diet were injected subcutaneously with the substance investigated and killed after two days. This interval was chosen because two days after injection with fluorine, the calciotraumatic line, hypo- and hyper-calcified zones are very clear and easily measured. The following substances were given: sodium fluoride, potassium oxalate, sodium citrate, manganese sulphate, calcium chloride, strontium chloride, disodium hydrogen phosphate, magnesium chloride, sodium molybdate, aluminium chloride, beryllium nitrate, lead nitrate, borax. The dosage was between 100 and 200 mgm. of the element concerned, per kilogram body weight, in all cases where the animals would tolerate this. In some cases (fluorine, beryllium) the dosage had to be greatly reduced. The amounts of oxalate and citrate injected were equivalent in calcium combining power with the fluorine injected.

The results obtained showed that, at any rate in rats on normal diets, a great many substances could produce results similar to those of fluorine. In no case, however, was any effect on the organic enamel found. The following produced a typical fluorine-like effect in the dentin: oxalate, manganese, calcium, phosphorus, magnesium, molybdenum and beryllium; measurements showed that the effects were caused, as with fluorine, at the time of the injection. Strontium and aluminium produced reactions, but unlike those of fluorine; the strontium reaction was a complete cessation of calcification in parts of the dentin. The following had no effect: citrate, lead, boron.

The animals on the low ratio diet were transferred to this diet when between 50 and 60 gm. in weight, and were kept on it for 28 days. They were injected with the same substances (except magnesium chloride) and killed four days later. At the end of four days the fluorine line in the predentin is about 30 $\mu$ from the odontoblasts and can be well seen.

The results, using this technique, appeared to be much more selective. Apart from fluorine itself, the only other element which gave an identical continuous line in the predentin was phosphorus. Oxalate and manganese gave faint fragmentary lines. No effect was noted in the dentin or predentin with any of the other substances save calcium, which caused the same healing process to begin as occurs if the ratio of the diet is adjusted[5]. Tetany occurred in the animals

after injection of fluorine, oxalate, citrate, phosphorus and molybdenum. None of these substances, except fluorine, caused any change in the organic enamel.

While these results need considerable expansion, certain interesting points arise from them. While fluorine acts on both enamel and dentin, the other elements that imitate its action act only on the dentin. It has been already shown[4] that the action of fluorine on the enamel is independent of the calcium–phosphorus ratio of the diet but that on dentin depends on the calcium–phosphorus ratio, and it would appear possible that the first action is a direct one on the enamel organ, the second indirect, by altering the concentration of blood constituents. If this is true, then it would also be safe to conclude that the other substances here examined also act not only by altering the composition of the blood but have no direct action on the tooth. In any event it would be unlikely that such a diverse number of substances would act directly on the tooth, but they are all such as might affect calcium or phosphorus metabolism. It is interesting to note that with low ratio diets, tetany is not a requisite for the calcifying action in the predentin. Citrate in particular caused violent tetany, but had no effect on the tooth.

To summarize, it is possible experimentally to affect organic enamel and predentin formation separately or together. On normal ratio diets, fluorine affects both; on high ratio diets, fluorine affects only organic enamel formation; while on low ratio diets, phosphorus, and possibly other substances, affect only predentin formation.

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June 6.

[1] Weinmann, J. P., *J. Dent. Res.*, 21, 497 (1942).
[2] Wessinger, G. D., and Weinmann, J. P., *Amer. J. Physiol.*, 139, 233 (1943).
[3] Irving, J. T., *Nature*, 151, 363 (1943).
[4] Irving, J. T., *J. Dent. Res.*, 22, 447 (1943).
[5] Irving, J. T., results to be published.

## Artificial Production of Monstrosities in the Rabbit

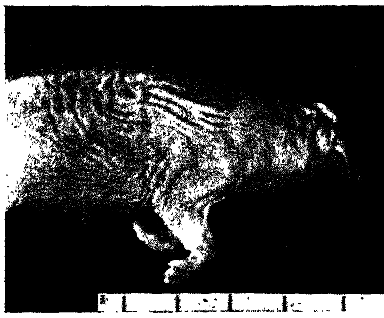

FIG. 1.

FIG. 2.

FOUR doe rabbits of unknown breeding were inseminated with the spermatozoa of one male suspended in a solution of 0·1 per cent colchicine in 0·9 per cent sodium chloride. Doe No. 8 gave birth to six normal young and one monster (Fig. 1). No. 13 gave birth to ten normal young; but on the following day was discovered devouring an eleventh, the normality or abnormality of which could not be determined. No. 14 gave birth to eight normal and one monster (Fig. 2). No. 16 gave birth to five normal and one with unclosed anterior fontanelle (Bregma) and with very small philtrum. This lived only five days. The experimental animals gave, therefore, twenty-nine normal young, two definite monsters, one defective young and one uncertain. In previous inseminations the same does had given fifty-nine young without abnormality. Since February, forty does of similar origin but also unknown heredity had produced 425 young from spermatozoa suspended in 0·9 per cent sodium chloride and no abnormalities had been observed.

In extensive rabbit breeding in Cambridge, similar monstrosities have not been observed. It seems therefore most probable that these monsters were produced by the colchicine, although it will be necessary to repeat the experiment on a larger scale and with inbred strains of known heredity in order to make quite certain that the results are not due to chance.

If attributable to the colchicine, it is likely that the effect is due to polyploidy or some disturbance of the nuclear mechanism or organizers in the tissues affected.

The effects of colchicine may be due to the substance being carried into the ovum by the spermatozoan, or being present in the oviduct and uterus and affecting the fertilized ovum at a later stage of development. Pincus and Waddington[1] treated fertilized ova *in vitro* with colchicine and other chemicals, and concluded that colchicine appears to be especially effective not only in preventing spindle formation and cytoplasmic cleavage, but also in inhibiting the normal movements of the pronuclei; tetraploid ova produced, failed to cleave over a culture period of one day, and the few that did cleave did so at a subnormal rate. Polyploidy has been produced artificially in insects and amphibian larvæ, but not so far as I am aware in mammalian embryos. Further systematic experimentation is planned in the hope that it may throw some light on the causes of embryonic monstrosities.

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June 8.

[1] Pincus, G., and Waddington, C. H., *J. Heredity*, 30, 315 (1939).

## Wöhler's Work on Urea

IN his interesting article on Wöhler's work on urea[1], Dr. Douglas McKie states that words spoken by W. v. Hofmann in 1882 in his obituary of Wöhler have given rise to a legend that Wöhler synthetized urea, thereby sounding the death-knell of the hypothesis of vitalism. I do not think any such legend exists.

It is well known that Wöhler arrived at urea through transformation of ammonium cyanate. There is no other interpretation of this fact, therefore also no legend. Dr. McKie bases his attack on

Hofmann on the grounds that a synthesis is only a synthesis if the compounds are built up from the elements. I would like to point out quite shortly that there are synthetic dyes, synthetic drugs, synthetic perfumes, etc., and we know that these products are produced neither in laboratories nor in factories from the elements. Terminology allows also synthetic precious stones, biosynthesis, etc., and has not followed Dr. McKie's exact definition. I admit that Wöhler's method for the production of urea might be more correctly termed a transformation than a synthesis; for in the year 1828 Wöhler was unable to produce urea either practically or theoretically from its elements. But in 1882, the situation had already changed, and Hofmann had a certain amount of justification in speaking of a synthesis.

The second legend, which Dr. McKie wishes to destroy, is that Wöhler's achievement sounded the death-knell of vitalism. I, for one, have never heard of this legend. Indeed, it is well known that even about twenty years after Wöhler's discovery, both Berzelius and Gerhardt, as well as many others, clung to the idea of the *vis vitalis*.

Had Hofmann's obituary of Wöhler been the only source for Wöhler's work and its consequences, he might have been considered to have originated such a legend; but this was not the case. One must also not forget, while criticizing Hofmann's words, that they occurred in an obituary, and not in a scientific dissertation, that they originated from his deep regard and respect for his great colleague and fellow countryman, who at the same time was one of the greatest chemists of his age.

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*Nature*, **153**, 608 (1944).

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It is curious that, in discussing this matter[1], Dr. D. McKie should make no reference to the classical experiments of Scheele. Out of consideration for space, I will do no more than quote the comment of Graebe[2] on the passage, cited by Dr. McKie, in which Wöhler questioned the significance of his preparation of urea:

"Dieser Einwand war aber schon durch Scheeles Versuche wiederlegt, da dieser das Cyankalium nicht nur mittelst Kohle, sondern auch mittelst Graphit erhalten hatte. Auch teilte im Jahre 1828 Desfosses mit, dass beim Überleiten von Stickstoff über ein zur Rotglut erhitztes Gemenge von Ätzkali und Kohle sich Cyankalium bildet. Inbetreff des Ammoniaks waren auch schon die Reaktionen bekannt, nach denen der Stickstoff der Luft sich in Saltpetersäure überführen und diese sich du Ammoniak reduzieren lässt."

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[1] *Nature*, **153**, 608 (1944).
[2] "Geschichte der Organischen Chemie", 55 (Berlin, 1920).

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The legend that I refer to appears in various textbooks and histories of chemistry and in works on general science. I have just read it in more than a dozen of them consulted at random. The sense in which I used the term 'synthesis' is neither personal nor *ad hoc*, and it is the same as that used by Hofmann when he wrote "der Aufbau des Harnstoffs aus seinen Elementen" in the quotation that I gave. My criticism of Hofmann did not, and could not, derive from any difference in the interpretation of this term, but from his statement that Wöhler built up urea from its elements and that the intellect of the time hailed his unification of chemistry with joy, which is untrue in every detail.

Hofmann made this statement in no hasty ephemeral tribute, but in a long contribution filling 164 pages of the *Berichte*. However, although there are reflexions of his words among later writers, I did not actually ascribe the origin of the legend to him. Still, if there should be any doubt about Hofmann's views after what I have already quoted, let us turn to the Faraday Lecture for 1875, a discourse on Liebig given by Hofmann before the Chemical Society of London:

". . . in 1828, Wöhler had demonstrated the possibility of building up from its elements this very urea, the formation of which, up to that period, had been supposed to take place exclusively under the influence of vitality—an experiment ever memorable, since it removed at a single blow the artificial barrier which had been raised between organic and inorganic chemistry."

This is not history, but nonsense.

Scheele's experiments are not classical in the history of the synthesis of organic compounds. In his researches on the colouring principle in Prussian blue (1782–83), the great Swedish chemist incidentally prepared, by the interaction at red heat of either charcoal or plumbago with potash (from vegetable sources) and sal ammoniac (from animal sources), the substance now known as potassium cyanide. Two of his reactants were derived from organic sources; their syntheses had not then been effected; and, moreover, it was not known at that time that the cyanogen group occurred in living matter. Scheele's production of potassium cyanide has therefore no historical significance in this field, and further comment on Graebe's statement is unnecessary.

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## The Cedar Tree

The cedar tree to which Mr. Alexander L. Howard refers[1] on p. 597, and before him the Rev. C. A. Jones, is Bernard de Jussieu's cedar tree in the Jardin des Plantes, Paris; it was planted in October 1734. Jussieu had been given the seed for it by Dr. William Sherrard, the distinguished patron of the Oxford Botanic Garden, and the great cedar tree there near Daubeny's laboratory was most probably planted at about the same time. The story about the transport of the little seedling in Jussieu's hat, or as the French call it *le fameux cèdre-bébé de Syrie*, is very charming; but it is a fairy tale.

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[1] *Nature*, **153**, 595 (May 13, 1944)

# RESEARCH ITEMS

### Metabolic Stimulants and Wound Healing

T. H. C. Barclay, D. P. Cuthbertson and A. Isaacs (*Quart. J. Exp. Physiol.*, **32**, 309; 1944) measured the time required for healing standard circular skin wounds in rats. In normal animals the time was about 20 days. Addition of dried thyroid gland to the diet throughout the healing period reduced the average healing time by 11 per cent. Addition of 2-4-$\alpha$-dinitrophenol (0·012 per cent of diet) reduced the healing time by 15–27 per cent. Larger doses of dinitrophenol (0·09 per cent of diet) were without effect, possibly because of the great loss of weight which occurs. The results were shown to be statistically significant; but the authors do not think that they justify the use of these stimulants to aid wound healing in patients. It has been shown by others that these substances have no effect on the rate of cell proliferation *in vitro*, and it is suggested that the *in vivo* effect may be due either to increased circulation-rate improving the blood supply to the wound, or to cell proliferation induced by some product of the increased body catabolism.

### Posterior Pituitary Extract and the Heart-Rate

THE slowing of the heart which results from injection of posterior pituitary extract has been ascribed to (1) reflex slowing from the rise of blood pressure, and (2) depression of the myocardium either directly or as a consequence of coronary vasoconstriction. M. E. M. Sawyer and G. H. Ettinger (*Canad. J. Res.*, **22**, E, 26; 1944) claim to have shown that neither of these factors is responsible. The experiments were performed on conscious dogs; the extract was administered by continuous intravenous infusion over a period of one to two hours at the rate of about 2 pressor units per hour. In normal dogs the heart slowed to about half its resting rate. Dogs whose hearts had been completely denervated (by a preliminary operation) showed no slowing at all; this confirms earlier work of Z. M. Bacq and S. Dworkin (*Amer. J. Physiol.*, **95**, 605; 1930) and proves that the slowing is mediated by the nervous system and is not due to any direct action of posterior pituitary on the heart. It would seem likely that the slowing is a reflex effect from the rise of blood pressure; but the authors present the following evidence against this view. In one dog the blood pressure actually fell by 5 mm. mercury, yet the heart slowed from 72 to 52 beats per minute. In the remaining six dogs the rise of pressure was small (10–30 mm. mercury) and the slowing was maintained for some time after the pressure had returned to normal. Such evidence is suggestive; but much more will be required before the effects of blood pressure changes can be ruled out.

### Cultivation of *Plasmodium gallinaceum* in Tissue Cultures

No one, says F. Hawking (*The Lancet*, 693; May 27, 1944), has yet succeeded in cultivating the trophozoites of malaria parasites *in vitro* for an indefinite period; but he has now succeeded in cultivating *Plasmodium gallinaceum* of birds in roller-tube tissue cultures of tissue from the spleen, liver, marrow and brain. It will be remembered that S. P. James and P. Tate (*Parasit.*, **30**, 128; 1938) showed that this and certain other avian plasmodia show stages which develop in reticulo-endothelial cells and in the capillary endothelium of the brain and other organs (the exo-erythrocytic forms). The occurrence of similar stages in the life-history of the human malaria parasite has not yet been proved. The commonest form of the parasite found by Hawking in his tissue cultures was the large oval schizont, which was usually found free from any cell. Small mononuclear forms were also fairly common. At the time of writing, Hawking had found apparently healthy parasites on the fifteenth day of culture, after which time the cultures were overgrown by fibroblasts. Tissue taken from tubes on the eighth day and injected intraperitoneally into chicks infected these with typical endo- and exo-erythrocytic forms. Fluid taken from several tubes on the ninth day and injected intraperitoneally into chicks infected them. Hawking thinks that multiplication of the parasites really occurs in the cultures, because, although parasites are hard to find in the original implant, they are present in large numbers after several days of cultivation, and clusters of tiny mononuclear forms are often found (which are figured), and these may be the results of schizogony. A detailed description of the forms of the parasites seen during this work will be published later.

### Venezuelan Catfishes

LEONARD P. SCHULTZ studied and collected the fishes in the Maracaibo Basin of Venezuela and other localities in the winter of 1942, and now makes a detailed report on some of them ("The Catfishes of Venezuela, with Descriptions of Thirty-eight New Forms", *Proc. U.S. Nat. Mus.*, **94**, No. 3172; 1944). 127 species and subspecies and 63 genera are recognized in this work—38 new forms are described and 6 new genera. Keys are given of the families, genera and species, and the whole will be a most useful help to all ichthyologists. The chief value lies in the fact that nearly all the material was collected personally and that colour notes were made from the live fishes. The common names are frequently included, and in several cases the young are compared with the adult.

### Asymmetry in Inheritance

G. DAHLBERG (*Proc. Roy. Soc. Edin.*, **62**, 20; 1943) has considered the question of asymmetry of pattern or of expression of such characters as polydactyly. Frequently such a character appears on one side in one individual and on both sides in another individual. Suggestions have been made that both environment and genes are the causative agents of this phenomenon. The author, however, indicated that manifold genotypical asymmetry, due to genic influence, will account for the apparently erratic behaviour. The final effects may arise from a gene or several genes acting at a particular stage in development where planes of symmetry are being formed. The genes may act by determining the distribution of extra-nuclear factors. This genotypic asymmetry entails a distinct form of latency to be distinguished from latency due to Mendelian recessives and from environmental thresholds. The author indicates suitable subjects for tests of the theory.

### Petrogenesis of the Transkei Dykes

NORTH of East London in the Cape Province of South Africa there are two immense dykes which, appearing near Cathcart, follow an easterly direction for nearly a hundred miles before they are cut off by the coast, where each of them has a thickness of about 1,000 ft. The various types of rocks which make up the dykes have been interpreted as differentiation products due to the fractional crystalliza-

tion of a dolerite magma (F. Walker, *Trans. Roy. Soc. S.A.*, **30**, 79; 1943); but a more detailed investigation has led E. D. Mountain to a very different conclusion (*Trans. Geol. Soc. S.A.*, **46**, 55; 1944). The main dyke-rock is a dolerite-pegmatite which differs chemically from the normal Karroo dolerite in containing higher potash and combined water, and lower magnesia. Patches of rock with the same characters have been produced in normal dolerite as a result of contamination by sediments, and Prof. Mountain presents evidence that the dolerite-pegmatite was formed by large-scale contamination of the same kind. As it is traced to the west, the southern dyke passes imperceptibly into normal Karroo dolerite. The northern dyke, however, becomes increasingly acid towards the west and finally becomes a quartz-felspar rock indistinguishable from a metamorphosed sediment. Along one stretch the northern dyke encloses a 20-ft. dyke-like band of essentially sedimentary material which can be matched with the neighbouring Beaufort sandstone. This 'dyke' persists for several miles; but eventually it grades into granophyric quartzite, which in turn merges continuously through granophyric dolerite into dolerite pegmatite. The rock sequence from dolerite to sediment is identical with that commonly observed in the reaction rims around sedimentary xenoliths found in dolerite.

### Solubilization by Soap Solutions

THE name 'solubilization' is applied to the power possessed by even dilute water solutions of soaps (and other colloidal electrolytes) of bringing into thermodynamically stable colloidal solution such substances insoluble in water as hydrocarbons and dyes. The commercial importance of this phenomenon has long been known; but its mechanism has only recently been given by J. W. McBain as consisting of sorption upon, or incorporation within, colloidal micelles. J. W. McBain and K. E. Johnson (*J. Amer. Chem. Soc.*, **66**, 9; 1944) have now shown by measurements with a water-insoluble dye and four potassium soaps that the solubilization increases so rapidly with the higher soaps as to cast doubt on the suggestion that it is solution in the hydrocarbon fraction of the molecule; but rather favour its incorporation between the layers of lamellar micelles, the only form for which there is direct evidence. Potassium chloride greatly increases the solubilizing power of fully formed micelles and also produces in dilute solution micelles of still higher solubilizing power.

### Structure of Boron Carbide

THE very hard boron carbide, $B_4C$, has been examined by the X-ray method by Zhdanov and Sevast'yanov (*C.R. Acad. Sci. U.R.S.S.*, **32**, 432; 1941—in English) and by H. K. Clark and J. L. Hoard (*J. Amer. Chem. Soc.*, **65**, 2115; 1943), whose results are in agreement. The structure is very unusual, the type of co-ordination shown by the boron and carbon being curious. $B_4C$ belongs to a rhombohedral lattice, with constants $a = 5{\cdot}19$ A. and $\alpha = 66° 18'$, with three stoichiometric molecules $B_4C$ in the unit cell. The corresponding hexagonal lattice constants are $a = 5{\cdot}60$ A. and $c = 12{\cdot}12$ A. for a cell containing nine molecules. The structural units are a linear chain of three carbon atoms and a group of twelve boron atoms arranged at the vertices of a nearly regular icosahedron. Each boron has six-fold co-ordination, being bonded to five others in the same icosahedral group and to either a carbon or a boron. Thus a continuous three-dimensional network of boron runs through the crystal. A high degree of resonance leading to a condition not far removed from metallic binding is presumably of considerable importance in accounting for the stability of the structure, and the boron network is not of the ordinary covalent type.

### Squirrel-Cage Induction-Motor Starters

A PAPER by G. A. Wauchope (*J. Inst. Elec. Eng.*, **91**, Pt. 2, No. 20; April 1944) describes a recent development in this class of apparatus. In a pumping station in which were installed a number of pumping units automatically started and stopped by changes in water-level, the motors were of the 3-phase double-wound squirrel-cage-rotor type controlled by contactor-type star-delta starters. During the starting period, the current was found to be higher than anticipated, with the result that the starter overload releases had to be provided with special restraining devices to prevent tripping under normal starting conditions. It was further observed that the high current-peak occurred when the motor connexions were automatically changed from star to delta. This phenomenon occurred in installations where the motors were of the simple squirrel-cage type as well as where the rotors were of special design to limit the starting current. The author gives reasons for the occurrence of the phenomenon and describes a new design of star-delta starter for squirrel-cage motors which followed from the investigation. The starter enables squirrel-cage machines to be used in many fields where a slip-ring motor has formerly been essential.

### Invariants and Tensors

THE theory of invariants was much studied, particularly by Cayley, Sylvester and Clebsch, in the second half of the nineteenth century. Its central problem was, given an equation representing some geometric configuration, to find functions of the coefficients of that equation which were unchanged in form when the axes of reference were altered. In the twentieth century the theory of relativity brought into great prominence the use of tensors; these can be used for expressing physical laws which are independent of the axes of reference. These two theories have now been linked up together in an important paper by D. E. Littlewood (*Phil. Trans.*, A, **239**, 305; 1944). He proves that all the results of the older theory can be obtained in the new. Moreover, there is a close correspondence between the symbolic method for invariants, introduced by Aronhold and developed by Gordan, Grace and A. Young, and the tensor method. The chief difficulty in both cases is that, although it is easy to write down an unlimited number of expressions which have invariant properties, it is difficult to decide whether any one of these may not turn out to be identically zero, or whether any two of these may not represent the same invariant. To do this requires a somewhat elaborate technique. That for the symbolic method is based on ordinary algebra, but the corresponding technique for tensors is more akin to group theory, and in particular to the quantitative substitutional analysis of A. Young. It is remarkable that Young developed this, not from tensors, but from his work on the symbolic method. Littlewood's paper appears to open up several promising lines of investigation, some of which will be discussed by the author in a later paper.

# STIMULATION OF THE ANTERIOR HYPOPHYSIS BY ŒSTROGENIC HORMONE

By PROF. BERNHARD ZONDEK
Hebrew University, Jerusalem

RECENTLY, we have reported a series of findings showing partial blockage of the anterior hypophysis in rat and fowl by prolonged treatment with œstrogenic hormone[1,2]. In these experiments it proved possible to eliminate growth hormone and gonadotrophic hormone by treatment with œstrogens, and as a result eunuchoid dwarf rats and similarly impaired chickens could be produced. Growth was found to be inhibited by the treatment to 60 per cent in the rat and to 30 per cent in the fowl. Inhibition was marked when large doses of œstrogens were given for a longer period.

Stimulation of anterior hypophysis by œstrogenic hormone is less certainly established experimentally than is the inhibition of this gland by œstrogens. The starting point of the present investigation was the hypothesis that the degree of stimulation of the anterior hypophysis by œstrogens depends on the manner in which the hormone is administered. Continuous administration of hormone to the organism is best achieved by the implantation of hormone pellets as suggested by Deanesly and Parkes[3]. The daily resorption rate in this form of administration amounts to 1–5 per cent.

In our experiments we implanted 10 mgm. pellets of œstrone* in the uterine cavity of fifteen infantile rabbits. Ten of the rabbits succumbed from secondary peritonitis in the first month after implantation due to necrosis of the uteri as a consequence of continuous treatment with œstrogens[4].

*Giant Growth:* One rabbit 16 months after the implantation exhibited an extraordinary group of changes: namely, well-proportioned giant growth, the body weight attaining 3,900 gm., as against only 2,900 gm. in the control; enormously swollen breast glands, milk production equal to that usual in a lactating rabbit after parturition, and ovaries weighing 1·1 gm. (as against 0·2 gm. in the control) consisting of a solid mass of lutein tissue entirely free from primordial or mature follicles. Enormous alterations were also found in the other sexual organs, but could be attributed to local and direct effects of the implanted œstrogen. Thus, particularly large, benign tumour-like polyps were found at the portio uteri; excessive proliferation with polyp formation was noted in the vagina and uterine mucosa; and degenerative changes of a type already described[4], especially hyperæmia, bleeding and infarct-like necrosis of the myometrium, were detected in the uterus. Summarizing, it was possible to suggest that continual stimulation of the anterior pituitary with œstrone is able to induce hypersecretion of growth hormone, gonadotrophic hormone (luteinizing factor), and lactogenic hormone. Regular daily resorption of about 0·018 mgm. (= 180 I.U.) of œstrogen was necessary to obtain this effect.

A considerable obstacle to experimentation on stimulation of the anterior hypophysis by œstrone is the difficulty of inducing a regular resorption of tested œstrogen in optimum dosage. We attempted to reproduce our earlier results in two further series of implantation tests, but were able to elicit slight symptoms of somatotrophic, gonadotrophic and mammotrophic stimulation only in two out of thirty female rabbits implanted with œstrone. It seems that œstrogen resorption in optimum dosage is attained but seldom, and it is possible that the ideal œstrogen for stimulation would be one which is resorbed very slowly and gradually.

*Thyrotoxicosis:* In earlier experiments[5] on impairment by protracted œstrone treatment of anterior pituitary function in rats, three out of a hundred rats treated by us with 5,000–20,000 I.U. of œstradiol benzoate in twice-weekly subcutaneous injections gave a singular reaction. The three were females which had received respectively $2 \times 5,000$, $2 \times 10,000$, $2 \times 20,000$ I.U. of œstradiol benzoate weekly. In these individuals, seven months of œstrone treatment had elicited, not stunting of growth but typical symptoms of gonadotrophic and somatotrophic inhibition, and in addition clear-cut symptoms of Graves' disease, including a slight exophthalmos. The pronounced general body tremor induced in these animals by touch proved symptomatic of a state of extreme excitement and nervousness which was combined with diarrhœa and alopecia. The basal metabolic rate of the animals was found, in fact, to be 20 per cent higher than in untreated controls of the same weight or age, and than in other œstrogen-treated rats of the same experiment. The thyroid glands at death were not in a stimulated condition, which was in accordance with the clinical picture of the animals before death, the thyrotoxic symptoms having disappeared. It seemed from these results that symptoms of Graves' disease (increased basal metabolic rate, nervous excitement, tremor, diarrhœa, alopecia) and exophthalmos in female rats might be produced by constant œstrogen stimulation. It was found impossible, however, to produce such an effect regularly.

In another series of experiments, thirty female rabbits, weighing 1,000 gm. each, were used and in each was implanted in the peritoneal cavity (between uterus and rectum) a pellet of œstrone weighing 10 mgm. Since earlier experiments had indicated that about two thirds of the animals subjected to this treatment are liable to early death from local injury to the uterus, both uterine horns of all animals used in the present investigation were extirpated at implantation. The animals were kept in cages in groups of two, one control together with one implanted specimen. The diet was composed of beetroot, carrots, wheat, bran and cabbage.

One of the thirty rabbits developed striking symptoms of hyperthyroidism within four months after the implantation. An unambiguous exophthalmos, which became aggravated when the animal was excited by removal from its box, was developed. In addition, other thyrotoxic symptoms such as diarrhœa, loss of hair, nervous excitement, acceleration of breathing and of pulse-rate and loss of weight (implanted animal 1,150 gm., control animal 2,900 gm.) were evident. The animal, which normally would have more than doubled its weight, suffered entire loss of its fat pads. Progredient cachexia gave it an appearance of little more than skin and bones.

In a metabolism cage, the daily food intake of the thyrotoxic specimen was 760 gm., as compared with 920 gm. in a control rabbit of the same weight. The urine of the thyrotoxic rabbit contained 0·4 mgm. per cent urea in an average daily volume of 110 c.c.

* We are indebted to Dr. B. J. Brent, Roche-Organon Inc., Nutley, N.J., for his kindness in supplying œstrone.

Urine of a young normal rabbit of the same weight (1,150 gm.) contained 0·1 mgm. per cent in an average daily volume of 200 c.c. The thyrotoxic rabbit, therefore, excreted about 100 per cent more urea daily than a normal rabbit of the same weight.

Assay of the thyrotrophic hormone content of samples of blood and urine from the thyrotoxic rabbit by injection into guinea pigs did not indicate presence of an abnormally high amount of thyrotrophin.

The basal metabolic rate of the thyrotoxic rabbit, as compared with that of normal controls of the same weight, and of untreated controls of the same age but double the weight (2,900 gm.) was quite distinctive. The carbon dioxide production in the thyrotoxic animal averaged 1·2 gm., as against 0·9 gm. in the weight control, and 0·8 gm. in the age control. This means an increased basal metabolic rate of 30 per cent compared with the weight control, and of 50 per cent compared with the age control.

An electrocardiogram of the exophthalmic rabbit had the following features: normal sinus rhythm; frequency 292; *P*-waves invisible in lead I and sharp and high in leads II and III; voltage high in lead I, especially high in leads II and III (1·1 and 1·2 MV. respectively); *T*-waves flat in lead I; normally positive in leads II and III. Summary: tachycardia, high *P*-waves, and high voltage, changes similar to those found in Graves' disease in man.

The exophthalmos, first noted four months after the implantation of the 10 mgm. œstrone pellet, persisted for four months, then gradually decreased, vanishing finally at a term which probably followed closely on the completion of the resorption of the implanted hormone depot. During this period, the basal metabolic rate of the formerly thyrotoxic rabbit reverted to normal (0·9 gm.) and before death even became subnormal (0·78 gm. carbon dioxide per hour per kgm. rabbit). The subnormal phase did not persist, however, for very long, since the animal died suddenly of emaciation a month after the disappearance of the exophthalmos, that is, five months after the appearance of exophthalmos, and nine months after implantation of the œstrone pellet, the animal at death being about a year old. Repeated ophthalmologic examinations of the fundus throughout the entire course of the experiment failed to reveal any pathological change.

The thyroid gland of the experimental animal exhibited no remarkable macroscopic or microscopic change. This finding was to be expected, since the animal died a month after the disappearance of the thyrotoxic symptoms, and after the basal metabolic rate had returned to normal values. The orbita showed no residue of exophthalmic œdema.

Creatin and creatinin assays of the urine carried out on the animal during the last months of its life yielded a puzzling result: only traces of creatin and creatinin were detected, whereas controls showed normal values of total creatinin (60 mgm. per cent) and traces of creatin. The absence of creatin(in) in the urine of the test animal in the post-thyrotoxic period may be explained possibly as the result of a retention of protein-building substance by the body for purposes of regeneration.

The œstrone pellet implanted into the peritoneum at the commencement of the experiment was sought at autopsy but had been entirely resorbed. This finding accorded well with the observed disappearance of all symptoms of thyrotrophic stimulation one month before the death of the rabbit. On the assumption that resorption of the 10 mgm. œstrone pellet was complete eight months after implantation, the rate of resorption was approximately 0·04 mgm. (= 400 I.U.) per day.

While it has been demonstrated in earlier experiments that protracted treatment with large doses of œstrogens blocks part of the functions of the pituitary anterior lobe, the above experiments show that it is possible also to stimulate the anterior lobe by œstrogens. Appropriate dosage and steady resorption of the œstrogenic hormone seem to be of importance for the induction of the stimulating effect. For this reason experiments designed to stimulate the pituitary gland do not succeed regularly.

The investigation reported here was generously aided by a donation from the Ella Sachs Plotz Foundation.

[1] Zondek, B., *Lancet*, **230**, 10, 776 and 842 (1936).
[2] Zondek, B., *Fol. Clin. Orient.*, **1**, 1 (1937).
[3] Deanesly, R., and Parkes, A. S., *Proc. Roy. Soc.*, B, **124**, 279 (1937).
[4] Zondek, B., *J. Exp. Med.*, **63**, 789 (1936).
[5] Zondek, B., "Clin. and Exp. Investigations on the Genital Functions and their Hormonal Regulation", 145 (Baltimore: Williams and Wilkins, 1941).

# THE SCIENTIFIC OUTLOOK AND ITS PRESENTATION BY FILMS

By GEOFFREY BELL

THE new tools produced by men of science, particularly the instruments of mass communication, have placed the peoples of the world in a new environment. Characteristics of this are an immensely increased freedom of movement in space for every individual, and also an emphasis upon technology as a directive of social endeavour. We are having to adapt ourselves accordingly. Everyone now needs some knowledge of science, and a feeling for the scientific outlook if he is to live happily in this new environment. What means has the man of science to hand for presenting the scientific way of life so that it can become a habit of thought with the average person?

A quarter-century ago, Dr. Comandon, a biologist, wrote: "In our days, motion pictures are a necessity to the scholar who wishes to demonstrate to his colleagues transitory phenomena, delineate experiments or the general observation of things, beings or facts. . . . Some of these films, properly arranged, have proved useful for documentation, teaching and scientific propaganda."[1] These ideas have not been without fruit.

Before dealing with the broad problem, reference must be made to the use, mentioned here, of the film as a tool for scientific workers themselves. Science is no longer thought of as a regime of study and inquiry within watertight compartments of knowledge; it has come to realize that it must 'know itself'. At a meeting of the Association for Scientific Photography, Prof. Yule Bogue said: "Any particular branch of industry or science is largely dependent for its own advancement upon progress made in other branches. In order that the maximum benefits may accrue it is essential that knowledge of these advancements be disseminated as widely as possible."[2] It is the purpose of the Association for Scientific Photography to foster this use of the scientific film (as

well as the still photograph), as pleaded by Dr. Comandon twenty-five years ago. The cinema of to-day is itself an interesting example of the integration of departments of science, bearing fruit through this kind of synthesis. Its lenses, lighting apparatus, thermionic valves, photo-electric cells, and the acoustic design of its film studios and cinemas, all have their genesis in different branches of physics; while its photographic emulsion is a product of chemistry.

To what extent is the film being used for 'scientific propaganda', the fostering of that integration of science with society, which the man of science should demand of this, one of his own creations?

There is one direction of progress with which most people are familiar—the documentary and the instructional film. Documentary technique has been described as the "creative interpretation of reality". The more straightforward, less 'interpretive', treatment of reality produces the instructional or educational film. Part of the reality, which which the documentary film makers deal, is necessarily the relations between science and society. The film "Night Mail", for example, translated a technological achievement, the regular running of the Scottish night mail train, into an inspiring social document. "Song of Ceylon", an impressionistic documentary of life in Ceylon, had as part of its theme the impact of Western civilization (which includes technology) upon this Oriental culture. "Men of Africa", using a different, more factual technique, tells the same sort of story for part of Africa. These are three well-known documentary films. Yet none of them was set out primarily as 'scientific propaganda', though, in a large measure, that is what they are.

On another side the documentary film makers have courted science. Large commercial interests—notably gas and oil—were concerned with applied science, as well as sales promotion. They took the view that the best form of advertising was to inform the public about the techniques they used. Both interests made good expositional films dealing with aspects of their work, such as "How Gas is Made", "Oil from the Earth", "Lubrication of the Petrol Engine". They also made films with a wider emphasis, such as "Enough to Eat" (British Commercial Gas Association) and "Malaria" (Shell). Gas is used for cooking food, hence the interest of food problems to users of gas; oil is used for killing mosquito larvæ, hence the interest of malaria to oil users. Both films have a social value which soon becomes generally known—particularly if their approach is free from advertisement or bias, and has integrity. Hence their value from a public relations point of view. (It is worth noting, for example, that "Malaria", though made by an oil company, describes the use of Paris green as a means of killing mosquito larvæ alternative to the usual oil film.) The G.P.O. Film Unit (now Crown Film Unit) also produced such excellent expositional films as "How the Telephone Works", as well as the more 'human' documentary. Latterly, the chemical industry has produced a series of detailed instructional films on anæsthetics, and a long documentary—"The Harvest Shall Come"—which deals with the social and economic problems of the agricultural worker. The connexion of the chemical industry with medicine and agriculture is left to be assumed from the content, rather than explicitly stated in these films.

Such films are widely seen by audiences outside the public cinema. They are shown by clubs, institutes and film societies. Many are used in schools and technical colleges for direct teaching and for general educational purposes. The Services have been using them during the War. The War, in fact, has brought about an important development in this field; the Ministry of Information has become the central agency for Government film production. Besides films of general informative value, it has made films on civil defence, aspects of public health and of agriculture. They are available through the Central Film Library, which distributes them free to anybody wishing to show them. Most of them give the lay public a good elementary education in the applications of science with which they deal.

Besides these there is the 'popular science' type of film, best known of which is the Gaumont-British "Secrets of Nature" series. They were often produced in two versions—one for schools, and one with a 'popular' commentary for the cinemas. They were basically instructional films, pointing at scenes and facts rather than interpreting them in a wider setting.

All such films, particularly those obtainable from free libraries, were a potential source of supply for a new kind of audience—the scientific film society. In 1938 there were two of these—in London and Aberdeen. Then the War seemed to act as a stimulant. In 1941 there were six societies in Scotland[3], and in 1942 the Scientific Films Committee of the Association of Scientific Workers called a Scientific Films Conference, when it became clear that more societies would soon form. To-day there are in the British Isles some fifty scientific film societies. They are generally open to anyone who wishes to join, for an annual subscription of a few shillings; some half-dozen shows, of about two hours each, are given during the winter months, commonly at week-ends.

The interest of these societies is now brought to a focus by the Scientific Film Association[4], the present address of which is c/o Royal Photographic Society, 16 Princes Gate, London, S.W.7. The broad purpose of the Association is to develop the film medium in every way, to further the integration of science and society. It believes that the 'man in the street' must become the 'citizen-scientist'. The scientific film society which shows films to its members helps, in one way, to bring this about. For each such society forms an audience, at once appreciative and critical, which is a potential encouragement and guide to the makers of scientific films. Small and economically unimportant though it may seem, each such society is a growing point fostering the scientific outlook, and the Association encourages the formation of as many of them as possible.

The following things, among many, are needed: the development of a system of viewing, grading and appraising scientific films; a panel to advise film producers on scientific matters, and to check the accuracy of technical detail; technical assistance to scientific men and others working on scientific films; a free, central, scientific film library; and more scientific films in the public cinemas.

Most of these are long-term matters, though a beginning can be made now; a system of viewing and grading, for example, is being developed. But such things as the distribution of scientific films in public cinemas will take longer to achieve. This brings us to wider fields, outside the range of the physics and chemistry which produced the sound film. For the film has a unique power of conjuring into something very like reality a world which hitherto belonged only to the minds of men.

This has a special reference to the problem stated above—that social progress demands the integration of science and society. When this statement is made to the ordinary person, he has difficulty in even seeing its meaning. But in a film we can show him, let us say, a bare spot on a bacteria culture, where a Penicillium spore has fallen. We can show it to him through a microscope, and abstract ideas connected with it can be presented by a moving diagram; the scientific man's own deductions from this scene can be made 'real' by sound. The concept 'science' becomes something he can understand—in this case it may say "penicillin is bacteriostatic". The same film can also show wounded men being brought back from the coast of France and rejoining their families. The concept 'society' becomes also a real thing—ordinary people and their lives. The film can arrange its strips of celluloid so that the sounds and the pictures of these representations are linked together; science and society are shown to be integrated. The film brings to 'reality' something that is otherwise but a mind picture, inaccessible to many. Its audiences gradually become 'citizen-scientists' in the sense that they grow to appreciate that science is part of their lives.

But the film medium, like all scientific tools, is powerful for ill as well as good. It does not necessarily tell the truth—indeed there are certain fundamental difficulties in the way of its doing so. The viewing and appraising of films which deal with science is therefore an important task. The lives of such scientific workers as Pasteur, Ehrlich, Faraday and Curie have been put upon the screen, and in very different ways. Most recently, psycho-analysis has received the attentions of Hollywood. Some of these films are good in their effect; others are bad. Since the public will get much of its ideas of scientific workers and of scientific method from the cinema, it is vital that those ideas should be soundly inspired. It is more than a matter of physics and chemistry.

[1] From "The Film in National Life", published 1932 by the Commission on Educational and Cultural Films. The Commission was originally brought into being through the agencies of the British Institute of Adult Education and the Association of Scientific Workers. It resulted in the formation of the British Film Institute.

[2] See *Nature*, 151, 718 (1943).

[3] *Documentary News Letter*, August 1942, article on "Scientific Films in Britain".

[4] *Nature*, 152, 745 (1943).

## THE MAXWELL LABORATORY AT THE UNIVERSITY OF MOSCOW

By PROF. V. ARKADIEV

THE Maxwell Laboratory of Electromagnetism in the Physics Department of the Moscow State University was inaugurated twenty-five years ago, and this anniversary has been commemorated recently.

The work carried on in this Laboratory has dealt mainly with Maxwell's electromagnetic theory of light, with the view of the further development of its fundamental principles: (1) light as an electromagnetic phenomenon; (2) the optical properties of bodies (such as lustre, transparency, refraction of rays, etc.) can be computed in advance according to their electrical and magnetic properties. The laboratory work has established further the identity of light with electromagnetic waves and the analogy existing between the two latter aspects of waves. In 1922 the Laboratory discovered a new source of radiation, the mass-radiator; this enables one to obtain intermediate ultra-Herzian waves, which form a connecting link between radio- and heat-waves. In 1934 special plates, sensitive to Herzian waves, were invented and prepared in the Laboratory; these plates have made possible the application in radio engineering of methods employed in photography (stictography), namely, those of fixing the traces left by radio waves upon paper.

Shortly before the War, the Laboratory demonstrated the possibility of using radio waves for radioscopy and suggested special screens, luminescent under the action of centimetre waves, similar to those used for X-rays. In the course of the further development of Maxwell's theory, the Laboratory has elaborated a comprehensive theory of 'passive' spectra, the most interesting result of this theory being the application of spectral analysis to the study of the magnetism of bodies; this involves the application of methods of mathematical analysis of optical absorption spectra to the investigation of the process of magnetization, particularly of the magnetization of technical magnetic materials.

The theory of passive spectra has been applied to the behaviour of matter of every description, beginning with the ionosphere and gases and ending with its coarser aspects, such as resin, cast iron, ores and rocks.

The combination of Maxwell's electromagnetic equations with the laws of motion established by Newton affords the possibility of obtaining general equations, representing a scheme of the behaviour of matter along the entire scale of electromagnetic waves. Among other things the scheme enables us to deduce the dispersion of Debye's dielectrics, the magnetic dispersion of paramagnetics and Compton's formula for the refraction coefficient for X-rays. An analogous inference is obtained for the magnetic properties of ferromagnetic bodies in the region of the ultra-Herzian waves, where the magnetic spectrum of ferromagnetic bodies is transferred into its own 'Röntgen' region in which, owing to the high frequency of the vibrations, only insignificant vestiges of the magnetic properties can remain.

## AXIS ORIENTATION OF QUARTZ CRYSTALS

AN article by G. W. Willard (*Bell Lab. Rec.*, 22, No. 7; March 1944) deals with the methods used in inspecting quartz crystals and in determining the axis orientation. In the original crystallization of quartz, foreign substances, such as other minerals or bubbles of gas or liquid, may be included, and part of the inspection procedure is undertaken to locate such inclusions so that they may be cut away. One of the dangers of using plates with inclusions is that the resulting discontinuities in their elastic and thermal properties may cause them to crack under the influence of temperature changes. Another common defect is the presence of cracks, due either to the effect of inclusions or to the rough treatment the quartz receives in river beds or in being broken from its natural formation. These cracks may be completely internal and very fine, and thus not

apparent on casual inspection. Another common defect arises from small interior bubbles. These may be isolated or grouped irregularly, or in very fine form may exist in lines or in plane or curved sheets, when they are called needles, phantom planes, or veils. So common are defects in quartz that only one in a hundred of the mined stones is saved for piezo-electric use.

Besides these various physical defects, crystals as found may have two other types of defects that result from structural misgrowth of otherwise perfect crystals, and give no evidence of their presence during inspection in ordinary light. The two types of quartz crystals, right-hand and left-hand crystals, can both be used in electrical work, but a single plate should not include material of both types. Although twinning, or the presence of both types in the same crystal, is common, usually any one crystal is predominantly of one type. A region containing twinning usually consists of thin layers of opposite kind. Inspection for optical twinning consists primarily in locating these small regions of unusable material so that they may be discarded in cutting.

The other form of twinning that may be present is electrical twinning. With such twinning, adjacent regions of quartz have their electric axes of opposite poles. This form of twinning is also common, but it differs from the optical in that each type may occupy large regions of the same crystal. Either type is usable, but not both in the same plate. During inspection the dividing line between regions of different types is marked on the crystal, so that eventually the regions may be separated and each section cut properly with respect to its own electric axis. The article illustrates photographically various kinds of crystal faults and describes the laboratory apparatus and procedure employed in examining the crystals.

# FORTHCOMING EVENTS

## Tuesday, August 8

QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Exhibition of Specimens, and Discussion.

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER IN THE DEPARTMENT OF MATHEMATICS, an ASSISTANT LECTURER (temporary) IN THE DEPARTMENT OF PHYSICS, and an ASSISTANT LECTURER (temporary) IN THE DEPARTMENT OF ENGINEERING (with special qualifications in Electrical Engineering)—The Registrar, University College, Singleton Park, Swansea (August 5).

LECTURER IN MECHANICAL ENGINEERING in the Denbighshire Technical College—The Director of Education, Education Offices, Ruthin, Denbighshire (August 5).

LECTURER (woman) IN MATHEMATICS in the Bingley Training College—The Education Officer, County Hall, Wakefield, Yorks. (August 7).

ASSISTANT LECTURER IN MECHANICAL ENGINEERING, an ASSISTANT LECTURER IN ELECTRICAL ENGINEERING, and an ASSISTANT LECTURER IN MINING, in the Cannock Chase Mining College—The Director of Education, County Education Offices, Stafford (August 8).

SENIOR TECHNICAL OFFICER (temporary) at London Headquarters of the Ministry of Town and Country Planning—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. EA.950A) (August 10).

ASSISTANT EDUCATIONAL PSYCHOLOGISTS (2)—City Education Officer, 12 St. Giles Street, Edinburgh 1 (August 11).

ASSISTANT MASTER (Graduate) to teach MATHEMATICS in the Sheffield Junior Technical School—The Director of Education, Education Office, Leopold Street, Sheffield 1 (August 12).

TECHNICAL OFFICER—The Executive Officer, Holland War Agricultural Executive Committee, 15 Market Place, Boston, Lincs. (August 12).

ASSISTANT LECTURER IN METALLURGY—The Registrar, The University, Leeds 2 (August 19).

READERSHIP IN PHYSICAL ANTHROPOLOGY—The Registrar, University Registry, Oxford (August 31).

CHAIR OF ELECTRICAL ENGINEERING—The Acting Registrar, The University, Leeds 2 (September 30).

LIBRARIAN—The Librarian, Queen's University, Belfast (October 31).

LECTURER IN THE SCIENCE DEPARTMENT (principal subjects: Inorganic, Organic and Physical Chemistry, with subsidiary Physics)
—The Registrar, Merchant Venturers' Technical College, Bristol.

CHAIRS OF PATHOLOGY, PHYSIOLOGY and SURGERY in the Royal Faculty of Medicine, Baghdad, Iraq—The British Council, 3 Hanover Street, London, W.1.

SENIOR TECHNICAL OFFICER—The Secretary, Warwickshire War Agricultural Executive Committee, 8 Guy's Cliffe Avenue, Leamington Spa.

SPEECH THERAPIST—The Director of Education, Education Office, Chapel Street, Salford 3.

SCIENCE MASTERS (2), one PHYSICS and one CHEMISTRY, at Victoria College, Alexandria—The British Council, 3 Hanover Street, London, W.1 (endorsed 'Alexandria').

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

Scientific Proceedings of the Royal Dublin Society. Vol. 23 (N.S.),
No. 24: Studies in Peat, Part 11: Peat-Tar Oils. By J. Reilly, Patrick
Moynihan and Desmond Reilly. Pp. 239–246. 1*s*. Vol. 23 (N.S.),
No. 25: Studies in Peat, Part 12: Mona Wax (Irish Peat Wax) and
Emulsification. By J. C. Aherne and J. Reilly. Pp. 247–256+plate
10. 1*s*. 6*d*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams [47
and Norgate, Ltd.)

Report on the Extension of Scientific Research in Manchester
University particularly in relation to the Industries of its Area. Pp. [47
27. (Manchester: Manchester University Press.) 1*s*. net.

Agrarian Problems from the Baltic to the Aegean: Discussion of a
Peasant Problem. (Post-War Problems.) Pp. 96. (London and New [57
York: Royal Institute of International Affairs.) 3*s*. net.

Imperial Agricultural Bureaux. Joint Publication No. 7: Imperata
Cylindrica; Taxonomy, Distribution, Economic Significance and
Control. Pp. 64. (Aberystwyth: Imperial Agricultural Bureaux.) [57
2*s*. 6*d*.

Imperial Bureau of Plant Breeding and Genetics. Potato Collecting
Expeditions in Mexico and South America, 2: Systematic Classification of the Collections. By Dr. J. G. Hawkes. Pp. 142+2 plates. [107
(Cambridge: School of Agriculture.) 7*s*. 6*d*.

Imperial Bureau of Animal Nutrition. Technical Communication
No. 15: Minerals in Pasture Deficiencies and Excesses in relation
to Animal Health. By F. C. Russell. Pp. 91. (Aberdeen: Imperial [107
Bureau of Animal Nutrition.) 5*s*.

My Struggle: the Life Story of a London Paperhanger. By W.
Margrie. Pp. 12. (London: The Author, 65 Trafalgar Avenue, [107
S.E.15.) 3*d*.

Ministry of Health: Department of Health for Scotland. Report of
Inter-Departmental Committee on Medical Schools. Pp. 313. (London: H.M. Stationery Office.) 4*s*. 6*d*. net. [127

Report of the Astronomer Royal to the Board of Visitors of the
Royal Observatory, Greenwich, read at the Annual Visitation of the
Royal Observatory, 1944 June 3. Pp. ii+20. (London: Royal [127
Observatory, Greenwich.)

Victory Vision. By Clew Garnet. Pp. 40. (Canterbury: J. A. [137
Jennings, Ltd.) 1*s*. 6*d*.

## Other Countries

Indian Forest Leaflet No. 58: Studies on Adhesives, Part 7: Rape
Seed Protein-Formaldehyde Dispersions as Plywood Adhesives. By
D. Narayanamurti, V. Ranganathan and D. C. Roy. Pp. ii+7. 4
annas; 5*d*. Indian Forest Leaflet No. 59: Studies on Adhesives,
Part 8: Adhesives from Oil Seed Cakes and Whole Seed Meals. By
V. Ranganathan and D. C. Roy. Pp. ii+5. 4 annas; 5*d*. (Dehra [117
Dun: Forest Research Institute.)

Bernice P. Bishop Museum. Bulletin 174: The Polynesian Species
of Hedyotis (Rubiaceae). By F. Raymond Fosberg. Pp. 102+4
plates. Bulletin 177: A Revision of the Pteridophyta of Samoa. By
Carl Christensen (Seleginella, by A. H. G. Alston). Pp. 138+4 plates.
Bulletin 178: The Flora of Niue Island. By T. G. Yuncker. Pp.
126+4 plates. Bulletin 180: Report of the Director for 1942. By
Peter H. Buck (Te Rangi Hiroa). Pp. 41. (Honolulu: Bernice P. [117
Bishop Museum.)

Occasional Papers of the Bernice P. Bishop Museum. Vol. 17,
No. 11: Apioninae and Brachyderinae of Fiji (Coleoptera, Curculionidae). By Elwood C. Zimmerman. Pp. 151–170. Vol. 17, No.
12: New Hawaiian Species of Peperomia. By Harold St. John.
(Hawaiian Plant Studies, 10.) Pp. 171–176. Vol. 17, No. 13: Distribution of the Ophioglossum on Islands of the Pacific Ocean. By Harold
St. John. (Pacific Plant Studies, 2.) Pp. 177–182. Vol. 17, No.
14: Some Curculionidae from Rotuma Island (Coleoptera). By
Elwood C. Zimmerman. Pp. 183–190. Vol. 17, No. 15: Fijian
Tingitidae (Hemiptera). By C. J. Drake and M. E. Poor. Pp. 191–206.
Vol. 17, No. 16: Notes on Polynesian Glochidion and Phyllanthus.
By Leon Croizat. Pp. 207–214. Vol. 17, No. 17: New Fijian Peperomias. By T. G. Yuncker. Pp. 215–220. Vol. 17, No. 18: Descriptions
and Records of some Fijian Psyllidae (Homoptera). By Leonard D.
Tuthill. Pp. 221–228. Vol. 17, No. 19: Anatomical Studies of Three
Species of Ouagapia. By Yoshio Kondo. Pp. 229–248. Vol. 17, No.
20: Land Shells (Synceridae) from the Southern and Western Pacific.
By C. Montague Cooke, Jr., and William J. Clench. Pp. 249–262.
Vol. 17, No. 21: A New Species of Elasmias from Rurutu, Austral
Islands. By C. Montague Cooke, Jr., and Yoshio Kondo. Pp. 263–266.
Vol. 17, No. 22: Thysanoptera of Fiji. By Dudley Moulton. Pp. [117
267–312. (Honolulu: Bernice P. Bishop Museum.)

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## CONTENTS




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# WATER POLICY IN GREAT BRITAIN

PUBLIC interest and concern regarding water-supply, expressed in Parliament, in the Press and in the debates of various professional bodies, has never been so general, or so generally well informed, as it is to-day. Interest increases primarily because of almost chronic threats of shortage, which only the foresight of water engineers has usually prevented from becoming actual. The threats themselves occur because the ever-growing demand outstrips provision. Growth of population in 'new' centres is an obvious problem ; but in general it is of far less importance than the rise in standards of living. Populations which were satisfied fifty years ago with a daily supply of ten or fifteen gallons a head are now barely served with thirty. Even less generally appreciated is the ever-growing demand of industry. The concern increasingly felt has been stimulated by a recent succession of serious droughts. Finally, the feeling that something is wrong has almost certainly been brought to a climax by the war-time experience that demands can be met 'when the devil drives'. The stupendous requirements of camps, aerodromes and factories have been surprisingly fulfilled, mainly by resort to underground water.

The foregoing circumstances explain the recent production of the White Paper on "A National Water Policy" (Cmd. 6515. London: H.M. Stationery Office), and the joint debate in April, arranged by the Geological Society and the Institution of Water Engineers, on "Water in Relation to Town and Country Planning". Some of the main points raised during this meeting are presented elsewhere in this issue (p. 171), and a fuller account has been published by the Geological Society. Shortly before the meeting was held, the Institution of Water Engineers had issued a statement on "Post-War Water Supply", and the Labour Party a pamphlet on "Post-War Water Policy". All who read and compare these various documents must be struck by the great measure of agreement regarding the nature of the problem, and the lines along which its solution must be sought. Behind the growth of this unanimous and informed opinion lies the slowly maturing efforts of water engineers and geologists over a period of many years.

The initiation in 1924 of regional advisory water committees, assisted by the Ministry of Health, was one of the earliest developments in water-supply planning. Slightly earlier, the Ministry had instituted its own Advisory Committee on Water, the original constitution of which was broadened and improved in 1937 when it became the Central Advisory Water Committee, with a mandate to advise the Government on water and water legislation. It proceeded rapidly to produce a series of reports which have formed the main inspiration of the White Paper. Meanwhile, in 1935, the efforts of certain engineers and geologists resulted in the foundation of the Inland Water Survey, with the object of procuring and publishing information, particularly concerning river

flows and their variations. An excellent start was made with the Surface Water Year Book (1938), further publication of which was unfortunately suspended by the War. To this brief indication of recent efforts to collect and utilize information regarding the water resources of Great Britain, there should be added the contributions concerning underground water made over a much longer period by the Geological Survey in general memoirs and maps, in special water-supply memoirs, and since 1939 in its Wartime Pamphlets.

A fair picture is given by the White Paper of the existing chaos of water legislation and organization, with Parliament as the sole authority able to empower the taking of surface supplies (representing about three-quarters of the total), and the Ministry of Health practically responsible for underground supplies, but without adequate powers. Actual undertakings are in charge of far more than a thousand authorities, public and private, statutory and non-statutory, dealing with quantities which vary from a few thousand gallons a day to the 300 million gallons a day of the Metropolitan Water Board. Many Government departments have varying degrees of interest in water and rights of control or comment. Yet it still remains true that the private owner of land in Great Britain has unrestricted rights to do what he pleases with any quantity of water he can extract from the ground.

The White Paper proposes the revision of the general law governing water supplies (the out-of-date Waterworks Clauses Acts of 1847 and 1863), and the simplification and co-ordination of the means for their provision and control. Some progress in the first has already been made with the Waterworks Undertakings Bill of 1943. For the latter, the White Paper proposes machinery which may work well enough, given goodwill and understanding all round, but which is certainly open to the criticism of being unnecessarily complicated. The general argument on which the proposals are based, that change is undesirable unless it will lead to improvement, leads properly to the conclusion that existing water authorities should not be disturbed so long as they are providing efficient and economic service. But it does not necessarily follow that the rather haphazard group of bodies concerned with the investigation and general control of water and water-supplies should also be preserved.

The most vital proposal is that all general control should be centred in the Minister of Health, with appeal to Parliament only in cases in which matters of major policy or public interest may be concerned. The Minister is to be given wide powers to promote and authorize the provision of supplies, to require amalgamation of undertakings, to survey their efficiency, to protect resources, and to require information from users and sinkers. He is to be advised on general policy by a further reconstituted central advisory committee, made statutory; and on local matters by the regional committees, also reconstituted and increased in number. The investigations of the Inland Water Survey are to be promoted, and further information as to needs and supplies is to be obtained through the Ministries of Agriculture and Fisheries and of Town and Country Planning. Reference to the important geological aspects of the matter are somewhat vague. The valuable work of the Geological Survey is acknowledged and a summary of those aspects, contributed by the Survey, is included as an appendix. It is stated that the Survey will be "mainly responsible" for the provision of information regarding underground resources, though the Inland Water Survey is charged with collecting the same data. The matter is further complicated by the proposal, excellent in itself, to set up twenty-nine river boards with broad powers for the general care and supervision of river-systems. But among the duties assigned to them is the regular gauging of rivers, which is the main purpose for which the Inland Water Survey was instituted. It is indeed a little bewildering to contemplate the number of separate authorities to which the same data may have to be returned, unless very careful co-ordination is maintained.

While these incidental comments on detail suggest that the scheme is not fully matured, there can be no question of the value of the White Paper as a whole. Perhaps the most serious reflexion which will occur to the careful reader will concern the magnitude and complexity of the whole question, and a doubt whether it should be dealt with by a section of a Government department primarily concerned with quite different matters. There is much to be said for the proposal virtually common to the pamphlet of the Institution of Water Engineers and the Labour Party's "Post-War Water Policy", that there should be a "permanent Statutory Authority . . . analogous to the Electricity Commission" or a "National Water Commission". No single service is of greater moment to the nation than its water, nor does any make a greater demand for expert control.

## SCIENTIFIC RESEARCH IN BRITISH UNIVERSITIES

EVERY scientific worker will acclaim the example to British industry which has been set by the directors of Imperial Chemical Industries, Ltd., in providing for eighty fellowships at nine universities in Great Britain to be held by senior workers in certain sciences. The need for provision of this kind has been repeatedly stressed in various reports and papers on scientific and industrial research; for example, those from the Parliamentary and Scientific Committee and the London Chamber of Commerce, and in the more recent statement from Nuffield College. The debate had reached a point at which action was clearly called for, and in the scheme which is now announced, the directors of Imperial Chemical Industries, who had obviously been following the debate closely, have given a timely lead.

Study of the scheme indicates that its terms are as admirable as its generosity, and Lord McGowan's letter to the chancellors of the universities also testifies to the careful consideration which he and his

colleagues have given to the question in all its aspects. There is no confusion here between the strategy and the tactics of research. The main purpose of the scheme is to strengthen the general provision in British universities for scientific teaching and research. It is a concrete reaffirmation of the opinion so strongly emphasized in the recent report on the extension of scientific research in the University of Manchester, particularly in relation to the industries of its area, as to the relation between teaching standards and research and between industry and the universities—a report which, it will be noted, has already been endorsed by Dr. C. J. T. Cronshaw, one of the directors of Imperial Chemical Industries. As Lord McGowan's letter puts it: "Nearly three generations of experience of the administration and conduct of research have convinced us that academic and industrial research are interdependent and complementary, and that it is useless to expect substantial advances in industry without corresponding advances in academic science".

The relation between industrial and academic research could scarcely be better expressed, and the scheme encourages further the relations between teaching and research which should help to meet some recent criticism in this respect. Again, the point that in the strategy of research the first essential is to obtain men of the requisite ability is well seen in the hope of the directors of Imperial Chemical Industries that this policy, with wise selection of men as regards capabilities and tenure of office, will lead to the emergence of a body of men capable of taking high academic or industrial positions, thereby advancing academic and industrial research. If in fact such leaders are forthcoming—and there is no reason for doubting that they will be—there need be no fear that the correct tactics of research will not be devised or employed.

In seeking to strengthen the university scientific departments in whatever way each university thinks fit, the scheme makes the one prescription that the subjects of research should be "in chemistry or physics or in an allied science which has some direct relation to the manufacturing interests of Imperial Chemical Industries, Ltd., such, for example, as physical chemistry, biochemistry, colloid science, chemotherapy, pharmacology, engineering, or metallurgy". That prescription is broad enough to cover the whole scientific background of modern industry. Moreover, the universities to which this offer has been made have been selected on account of their size or metropolitan character or their geographic relation to the main centres of the Company's production. The challenge to the fuel, the metallurgical and the Yorkshire textile industries implied in the omission of the Universities of Leeds, Sheffield and Wales is unmistakable.

Only the most carping criticism could object that the scheme may further weight the balance of research in the universities in favour of the physical as against the biological or social sciences. Lord McGowan's letter indicates that nothing could be further from the minds of himself and his fellow directors in putting forward the scheme: it is rather their hope that it will be used by the universities to improve the balance of research effort, either in a particular university or between one university and another. It is difficult to conceive of a scheme better designed to safeguard the freedom of the universities in every way while encouraging the co-operation required to facilitate any redistribution of their research effort in accordance with a broad programme based on national needs. It will not escape notice that among the subjects of research enumerated are included some to which Sir Ernest Simon and others have already directed attention with the view of eliminating redundancy, promoting the effective development of existing schools and the provision of new schools to fill recognized gaps, through university consultation and co-operation.

The evidence of close and wise thinking which characterizes the whole scheme should commend it unreservedly to scientific workers. It is hard to imagine a scheme which could provide a more stimulating example to British industry and more practical encouragement to the scientific work of the universities, while avoiding any interference with their freedom of work; or at the same time provide for immediate action without prejudice to the large questions of strategy which are still being debated.

On the heels of this statement from Imperial Chemical Industries, Ltd., on research comes the announcement from the Bank of England that it is setting aside £100,000 for the establishment of a trust fund for the promotion of economic research (see p. 175 of this issue). In this case the trust will award fellowships, and there is no stipulation that the research is to be carried out in university institutions; but there is little doubt that the universities will benefit from the increased facilities for research in economics. Chemical industry and high finance have thus endorsed the claims of research: it is surely not too much to expect that the example they have set will be studied carefully—and acted upon—by industry in general.

## MINING AND MINERS

### The History of Miners' Diseases

A Medical and Social Interpretation. By Dr. George Rosen. Pp. xii+490+17 plates. (New York: Schuman's, 1943.) 8.50 dollars.

THIS history covers a wide field. Part 1 begins with neolithic times, when the flint miners apparently suffered from silicosis, which is hence the oldest known occupational disease. The author then discusses the mining situation during the Middle Ages and the Renaissance, and finally reviews the investigation of miners' diseases during the seventeenth and eighteenth centuries. Part 2, which forms the bulk of the work, is confined to the nineteenth century, and deals with mining and miners, the diseases of miners, and the beginnings of social and protective legislation. Most of the important work on these subjects, however, belongs to the twentieth century, and we endorse the hope expressed by Prof. Sigerist in his introduction that the author will now write a second volume in which the history of the last fifty years will be discussed.

Dr. Rosen is presumably an American, and his book is published in the United States; but it is confined entirely to the mining industry of Europe and Britain, the latter country predominating. He has produced a fascinating, restrained and well-documented work, but one which attributes little credit to those responsible for the development of the mines. For a long time Parliament was not aware of the shocking conditions under which the miners worked and of the sufferings of these unfortunate men above as well as below ground, and even when the facts were disclosed, and ignorance could no longer be pleaded, the very moderate remedial measures proposed were whittled down in both Houses, and no serious attempt was made to enforce them when they became law. Very young children were made to work underground for eighteen hours a day, and, as one author remarks, the diseases contracted in the mines compelled the men themselves to quit the pits between the ages of forty and fifty, and led them slowly but cruelly to the grave. The medical profession itself was singularly unfortunate in its researches. For many years it was denied that the black lung of coal-miners was the direct consequence of their occupation, and, when this was ultimately disproved, it was held that any inhaled dust was not only harmless but might even be beneficial, and the victims of pulmonary tuberculosis were recommended to spend a part of their time in the mines inhaling a foul and dust-laden atmosphere. It took decades of research to establish the simple fact that the pulmonary organs of coal-miners were impregnated with coal dust, and no solution of the problems of pulmonary anthracosis was possible until the extraneous origin of miners' black lung had been irrefutably established.

In 1813, Pearson had asserted, as the result of chemical experiments, that coal dust entered the lungs with inspired air, but the crushing authority of Virchow delayed the recognition of so obvious a truth for many years, until even he himself was finally constrained to withdraw his opposition. Dr. Rosen points out that it was not until the sixteenth century that we have any clear information of the occupational diseases of mine-workers. This knowledge we owe to the works of Paracelsus (1533–34) and Agricola (1556), the latter being responsible for the first complete treatise on mining. Incidentally, he refers to the presence of venomous "ants" in the silver mines, which were possibly a species of Galeodes.

Paracelsus was the first to investigate miners' diseases in any detail, and he deals with a well-defined occupational group—the mine-workers and smelters. He recognized two common types of miners' diseases, one associated with the respiratory tract and the other with acute and chronic poisoning due to the ingestion and inhalation of poisonous metals. Few miners reached middle age, and Fallopius found that most of the workers in the quicksilver mines died from mercury poisoning after three years in the pits. Stockhausen, who laboriously describes the revolting conditions under which the Prussian miners lived and worked, could only offer them the fatuous advice to "avoid all dust and fumes and live in such a manner that they will retain their strength"; and as to the presence of demons and ghosts in the pits, they must seek refuge in prayer and fasting.

In the seventeenth century a significant train of events was brought about by the prevalence of Cartesian views in physiology, according to which the human body was interpreted as a purely mechanistic complex. Physicians were thus induced to take up the study of mechanics, and this in turn led them to occupational diseases. Nevertheless, the seventeenth and eighteenth centuries produced nothing of importance in the treatment of miners' diseases, which was still based on Paracelsus. This was due partly to a serious decline in the mining industry itself, but also to the absence of any system of scientific pathology. The investigation of miners' diseases, in fact, practically came to an end, and was not resumed until the thirties of the nineteenth century. In this century the great expansion in the mining of coal, due to the industrial revolution, revived an interest in the welfare of the miners. Coal was the basic factor in the situation, and Dr. Rosen traces the history of coal-mining in England as the country in which the most important developments occurred. Attention now began to be directed towards solving the vital problems of drainage, ventilation and underground haulage, with the result that steam-power was introduced, and mining engineering moved forward to occupy a prominent position in the organization of the mines.

Dr. Rosen has not told us much of the parasitic diseases of miners. He mentions that ankylostomiasis (hookworm disease or miners' anæmia) appeared in Hungary in 1786, and that there were epidemics of it in the coal mines of France in 1802 and 1820, by which latter date the disease was known to be widespread in France, Belgium, Hungary and Germany. It was not until 1882 that Perroncito showed that it was due to the nematode parasite discovered by Dubini in 1838 (published 1843). But the solution of this trouble belongs to the following century, with which the author has still to deal.

This important contribution to the history of medicine and sociology has been admirably produced by the publisher, in spite of the fact that good paper, printing and binding seem almost to have vanished from the earth. F. J. Cole.

## PROGRESS OF HUMANITY

**Progress and Archæology**

By Dr. V. Gordon Childe. (Thinker's Library, No. 102.) Pp. vii+120. (London: Watts and Co., Ltd., 1944.) 2*s*. 6*d*. net.

THIRTY years ago, most books on prehistory dealt exclusively with accounts of the various sequences of cultures which had been determined, and with the study of the material relics left by these ancient peoples. Nowadays the approach has shifted. There appears to be a greater desire to view the subject from a more human point of view. Of course, any evidence from the remote past, other than that furnished by relics which can survive, and have, must necessarily be somewhat conjectural; but so much has been learned about our forerunners and early ancestors that the attempt to visualize them as living men and women, not so unlike many of the primitive folk of to-day, is not so absurd as might at first be supposed.

The little volume under review is written by one of our foremost prehistorians, and he is here considering the progress of humanity. Certain vital aspects of life are dealt with in their relation to early man. Thus there are chapters dealing with the food quest, tools and materials, warmth and shelter, inter-

course and diffusion of cultures, funerals, sacrifice, etc. All the time, it is suggested, man accumulated knowledge which, notwithstanding temporary setbacks, was not forgotten.

Naturally, one cannot expect that in such a small volume chapter and verse could be given for every statement of fact made, and sometimes perhaps the peg upon which much theory has been hung is somewhat slender! For example, it has been suggested that certain reindeer found in a lake near Hamburg had stones attached to them and were sacrifices, and Prof. Childe seems inclined to accept the suggestion. Frankly, the evidence seems to be open to other interpretations, and one would like to be much more certain that the stones were really attached to the beasts with this intention. Excavators—even with the rigid discipline obtaining to-day—must exercise some imagination when attempting an explanation of what they find. Moreover, a tentative suggestion made by one author sometimes appears as a proved fact in the pages of another! When important conclusions hang on comparatively slender evidence, the student must, of course, remain severely critical.

It seems to me, when tracing the path of human discoveries and progress, that mass desire has often been the important factor. Once something is definitely wanted, again and again it has been produced in an extremely short time. Consider how very quickly after the discovery of the smelting of copper came the knowledge that the better material was bronze. Did a long period of goldsmiths' experience precede the making of the treasures of the royal tombs at Ur? How speedily did that scientific toy, wireless, once produced, become an everyday product capable of being manufactured by almost anyone! And this line of thought is applicable equally in the realm of ideas as in that of technical progress—in *intelligence* as well as in *habilité*. Conversely, nothing will teach the Bushmen of South Africa to plant and herd. They have no desire to do so. The difficulty nowadays is to direct the mass desire aright along a true, if unsurveyed, line of human progress. To ponder for a time on the problems of cultural evolution in the remote past with such a master of his subject as Prof. Childe does help us to orientate our minds, when we try to foresee the lines of development along which should run the future course of the progress of mankind.

M. C. BURKITT.

# DICTIONARY OF BIOCHEMISTRY

**Dictionary of Biochemistry and Related Subjects**
Edited by Prof. William Marias Malisoff. Pp. 579. (New York: Philosophical Library, Inc., 1943.) 7.50 dollars.

THIS 'dictionary' is a new and interesting venture and it is illustrative, perhaps, of the remarkable progress of biochemistry during recent years that such a dictionary should even have been contemplated. No one now would, I think, question that there is room in the literature for a book which will define clearly biochemical terms, give references to key papers dealing with investigations on the manifold aspects of biochemistry, describe succinctly biochemical laboratory tests in current use and, above all, give brief and accurate accounts of the present position of a large variety of biochemical topics. The task of producing such a book must indeed be formidable, for the greatest care is required to secure a balanced treatment of the topics and not to give undue importance to subjects and terms of little or fleeting importance, to insert only what is relevant to biochemistry and to omit the trivial.

Much care and thought clearly have been expended on the compilation of this dictionary, which does its best to steer a middle course between a glossary of terms and an assembly of review articles. Several thousand terms have received attention, and a large number of chemical tests of more or less importance in biochemistry have been described. The terms cover the field of biochemistry and invade neighbouring fields of anatomy, physiology, botany and zoology. The list of biochemical tests in current use is fairly comprehensive but by no means complete. For example, a description of the familiar Rothera test for acetoacetic acid is missing, nor does there seem to be an adequate description of current tests for thiol compounds. Moreover, the tests which are described often lack experimental detail so that little use can be made of them. Inclusion of references in all tests is obviously a necessity.

Certain topics are distinguished by having signed semi-review articles allotted to them. Thus amino-acids are dealt with by Van Slyke, autolysis by Bradley, carbohydrate metabolism by Barker, respiration by Gerard, cellulose decomposition by Norman, etc. Unfortunately, there is only a small number of such authoritatively treated articles. Further, the topics dealt with in this manner are ill-balanced in treatment, some topics receiving ten pages or more of discussion while others, equally interesting to the student of biochemistry, are discussed in a few short paragraphs. Many important topics receive the scantiest consideration. Thus the subject of glycolysis, which is certainly worthy of detailed treatment in a dictionary of biochemistry, is dismissed in a phrase: "Breakdown of sugars in body". This is scarcely compensated for by the article on carbohydrate metabolism, which only touches upon the chemical mechanisms of carbohydrate breakdown in the cell. Should the reader look up the term 'fermentation', he would be directed to 'microbiology', under which term he would certainly learn little of fermentation. 'Fat metabolism' receives sketchy treatment in an article on "Carbohydrate and Fat Metabolism and their Reciprocal Integration" by Witzmann.

The main body of the dictionary is taken up with definitions, cross-references and short descriptions, some of which are good, some very good, and others too poor to be regarded as of informative value. The reviewer also feels a definite dislike to the inclusion in a biochemical dictionary of such abbreviations as ADP, ATP, TPN, GSH, etc., which while useful in a scientific article (where they are defined) as leading to economy of space, cannot yet be regarded as internationally accepted symbols of the substances they represent.

Considerable cutting of the irrelevant material, inclusion of many more authoritative and comprehensive articles on the more important aspects of biochemistry, attention to the inclusion of key references and constitutional formulæ (which are mostly conspicuous by their absence) and elimination of descriptions of chemical tests not in general usage, would make this dictionary far more valuable and acceptable to the student and to the research worker.

J. H. QUASTEL.

# HEREDITY, DEVELOPMENT AND INFECTION

By Dr. C. D. DARLINGTON, F.R.S.
John Innes Horticultural Institution, London, S.W.19

## 1. Three Levels of Heredity

THE development of genetics has depended on the separation between determinants and what they determine, between factor and character, between gene and gene-product, between genotype and phenotype. Once the separation had been admitted in theory the connexion could be examined in practice.

This examination has proved that there are three systems or levels of determinants[1]. The first system and highest level is that which is most accurately and equally distributed at the division of the cell and most equally transmitted by the two parents in sexual reproduction. It is responsible for the Mendelian heredity of genes; it determines the widest range of hereditary variation; and its equilibrium is mechanical. Its transmission (with odd exceptions) is not influenced in any regular way by external or developmental conditions. It therefore predominates in the government of heredity as well as in the government of the cell. This is the *nuclear system.*

The second system, recognizable only in green plants, is liable to be unequal in its distribution at cell division and is always unequal in inheritance, being largely maternal in transmission. Its equilibrium is best described as physiological. This is the plastid or *corpuscular system.* The third system constitutes the undefined residue of heredity, not associated with any visible bodies in the cell and hitherto supposed to be purely maternal in transmission. This cytoplasmic or *molecular system* must depend on chemical rather than on mechanical, or even physiological, equilibrium for its continuance.

The study of the plastid and cytoplasmic systems has been long delayed. For, as we now see, their properties can be resolved only in terms of a previously acquired knowledge of the nuclear system with its differentiation into chromosomes and genes. We can get to know extra-nuclear heredity only in terms of relationships. The first steps were made by the study of differences between reciprocal crosses of species or races in flowering plants. These were frequently male-sterile in the $F_1$ one way, although normal the other way. In other crosses, for example in the tomato, the difference was one of size and expressed itself both in $F_1$ and in the segregating $F_2$[2]. Or again, if the $F_1$'s were similar and normal, as in an upright-procumbent flax cross, abortion of the anthers, varying in degree, according to the races used, appeared only in a quarter of the $F_2$'s from crossing one way[3]. Thus the defect arose out of the reaction between a single, ambilinear, recessive gene from the nucleus of one parent and a matrilinear cytoplasm from the other.

The commonest markers in these cases are defects, and this suggests that the cytoplasm in heredity is to be regarded as a negative factor; but recent evidence points to a positive activity. Mather[4] finds that the cytoplasm of a self-compatible species of Petunia frequently gives male-sterility with the nuclear system of a self-incompatible species. The opposite combination is always normal. The same is true in Nicotiana[5]. Mather therefore suggests (unpub.) that the nuclear and cytoplasmic systems of self-incompatible plants are mutually and constructively related. Thus we may have to admit that the cytoplasmic system is not an obstacle to adaptation but an instrument of it.

## 2. Plastogenes

If the cytoplasm is adaptive, it obviously cannot be considered as a unit in adaptation. It must be composed of different determinants. The simplest evidence of this kind of organization, however, comes from the plastids. The plastids differ from other organs in the cytoplasm in that their separate inheritance and separate actions can be seen in individual cells. The critical step in their understanding was made by Renner[6,7].

By reciprocal crossing of two species of *Oenothera, muricata* and *hookeri*, Renner combined the ambilinear nuclei with the largely maternal plastids in four combinations, with the following significant result:

| | Nuclei *hookeri* | Hybrid |
|---|---|---|
| Plastids *hookeri* | Green | White |
| Plastids *muricata* | Green | Green |

The *hookeri* plastids thus turn white with the hybrid nucleus; but they turn green again in the next generation when restored by back-crossing to the *hookeri* nucleus. Evidently two kinds of nuclei with their genes are at work, and two equally permanent kinds of plastids. Such plastid differences imply the action of determinants or *plastogenes*, as Imai has called them[8]. How then do the plastogenes act? We might say that the nuclei control their activity. But it would be safer to say that the joint reaction of nuclei and plastogenes determines whether the plastids are white or green. The nuclei and the plastogenes are then, as Renner says, mutually adapted in each species to the production of chlorophyll, and this adaptation is upset in hybrids.

There is one way in which the nucleus might, however, be said to control the plastogenes. It might control, not their activity, but their mutation, which (as soon as we separate determinant from product) is an entirely different thing. The distinction between joint action and controlled mutation is well recognized in the relations of nuclear genes. Not only the genotype as a whole but even a specific, mutation-producing, gene can be shown to control the time and place of mutation of another gene the action of which is directly observable[9]. Control of plastogene mutation by the nucleus is unlikely in the Oenothera case, for it would require capacities in nuclei for instantaneously producing and reversing mutations in particular kinds of plastogene. If, however, we were to find delayed, and preferably irreversible, changes arising in otherwise autonomous plastids when they were in association with specific nuclei we should have evidence of controlled mutation. Such situations have been described by Imai[8,10] in barley, rice and elsewhere.

In barley the recessive 'variegated' homozygote is characterized by casual mutation in early life of some of its green plastids to white; and the plastids, being corpuscular, are sorted out to give green cells and tissues and white cells and tissues. The plastids are then autonomous. They are inherited only from the mother and they do not mutate back to green under a 'green' nucleus, which is indeed merely effective in stopping further mutation. Thus, equally in 'varie-

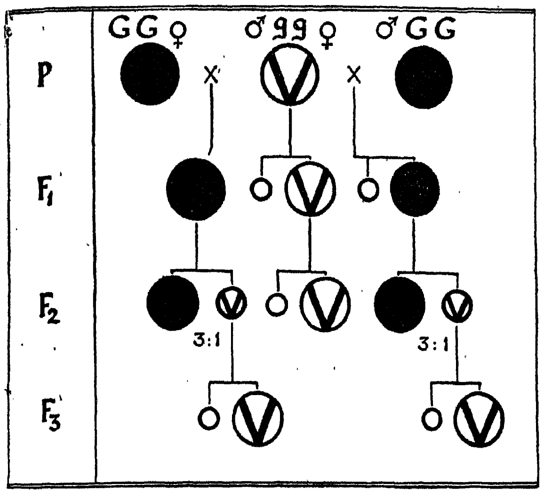



FIG. 1. *Hordeum vulgare* AFTER IMAI. BLACK CIRCLES ARE GREEN PLANTS; WHITE CIRCLES WHITE PLANTS; AND V CIRCLES VARIEGATED. SIZE OF CIRCLE INDICATES FREQUENCY OF SEEDLINGS.

gated' selfed and in its cross with 'green' pollen, a small proportion of the seedlings contain only white plastids and die; a still smaller proportion are mosaics from mixed egg cells; the rest are variegated in the selfed family, green in the cross (Fig. 1).

The same principles apply to a variegated rice[11], but a third instance in maize extends the technical possibilities[12]. Plastid equilibrium is physiological. The times and stages of mutation, and of sorting out or distribution, are both under genotypic control. They begin earlier in the maize than in the barley. Hence it gives wholly white ears which, with any pollen, bear wholly white seedlings. Late mutation, as in barley, gives egg cells having mixed plastids, green and white; these eggs, with any pollen, yield mosaic seedlings, again with some wholly white ears; and these, in the next generation, give purely white seedlings, some of which have homozygous green nuclei. Thus no kind of nucleus can make the mutated plastids change back from white to green.

In all these cases the variegated gene has a capacity (a limited capacity) for changing the plastogenes, irreversibly, from green to white. Thus the control of the nucleus is not continuous and direct but *mutafacient* and indirect. Imai, Pal, and Rhoades are able to prove this because the mutafacient capacities of the two alleles are sharply contrasted. Reactions might be otherwise if the genes and plastids concerned were recombined with the corresponding elements in the nearest relative (for example, teosinte for maize); but this could only reveal a more complex situation, not a less complex. In another variegated rice Imai has indeed shown such a complexity. Here the plastids behave like those in maize and barley, but the nuclear control is different. Individuals with non-mutable plastids arise from those with mutable plastids and the change is not controlled by a single nuclear gene. The plastids therefore simulate an autonomous mutability. Such a continuous variation in mutability, however, merely suggests polygenic control by the nucleus which in this field, as elsewhere, has hitherto been left to the account of indeterminacy.

## 3. Plasmagenes

How far are we justified in assuming the same kind of determinant in the cytoplasm where determinants are not fastened to the immediate products of their activity? If we can show that there is not only an activity relation of nucleus and cytoplasm but also a mutafacient relation, the analogy with the plastids will be broadened and the assumption of unattached determinants vindicated. This relation has now been established by Sonneborn[13] in *Paramecium aurelia*, although his interpretation, failing to distinguish between 'factor' and 'substance' in the cytoplasm, does not relate it to the present discussion.

Alternative types exist in two races of this protozoan, one of which, the 'killer' (race 51), poisons the water for the other, the 'sensitive', type (race 32). The reciprocal $F_1$'s between them are each of the maternal type. The $F_2$ in the 'sensitive' line continues entirely sensitive. The $F_2$ in the 'killer' line, however, yields one quarter of 'sensitive' individuals which behave like the original 'sensitive' type. Thus between the two races there is a gene difference as well as a cytoplasmic difference: and while the 'killer' gene *K* cannot change the 'sensitive' cytoplasm to 'killer', the 'sensitive' gene *k* can change the 'killer' cytoplasm to 'sensitive' (Fig. 2).

As in the plastid cases, this effect is not instantaneous, although it might appear so in a larger organism: it takes place in 2–5 fissions; it waits on reproduction. Thus the *K* gene is ineffective and its *k* allele does nothing beyond causing a specific and irreversible hereditary change in the cytoplasm, that is, a mutation in a *plasmagene*, or the creation of a new plasmagene. The incidence of the mutation or creation in the Paramecium cross is thus the same as the incidence of the defect in the flax cross, namely, one quarter of the $F_2$ in one direction.

Two practical points will be noticed. From the crossing of the two races it is possible to get 'killer' and 'sensitive' stocks which are both *KK* and differ only in cytoplasm. Indeed, Sonneborn has a natural 'sensitive' stock (race 47) of the *KK* type although he does not ascribe such an origin to it. Further, it is also possible to get purely 'sensitive' stocks with uniform cytoplasm and differing only in having *K* and *k*, which difference will be seen only in the $F_2$'s that they will give with 'killer' stocks. As in all such cases the effective variable may be either nucleus, or

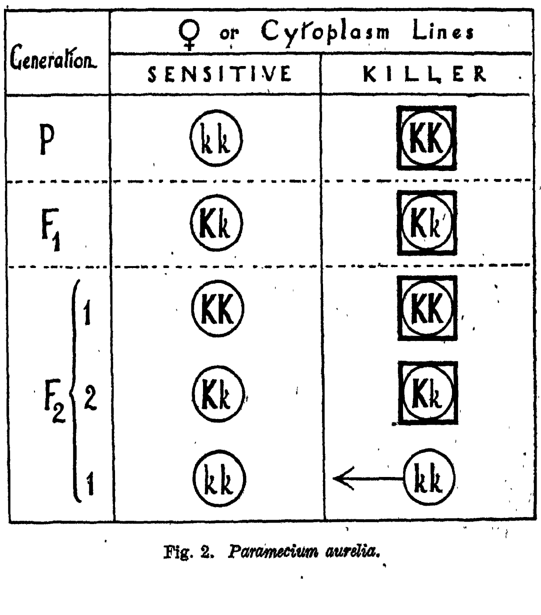



Fig. 2. *Paramecium aurelia.*

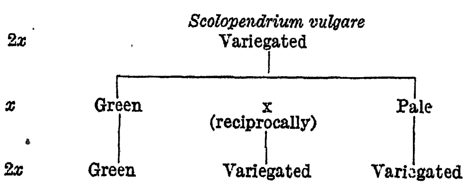
cytoplasm, or both, as we choose to arrange the experiment.

The question now arises as to how such plasmagenes maintain themselves. There are not only the two types responsible for the 'killer' and 'sensitive' reaction. Different strengths of reaction are also found in different 'killer' races. Are the plasmagenes of each of the different types uniform or can they be mixed in one individual? Here again an experiment of Sonneborn's is decisive. Permanent fusion of individuals sometimes occurs and gives rise to offspring of mixed cytoplasm. When two *KK* individuals fuse, one with 'sensitive', the other with 'killer' plasmagenes, all the progeny have 'killer' plasmagenes. Mixture is unstable and 'killer' is, we must not say dominant, but rather *suppressive*.

Thus the 'sensitive' plasmagene which is determined by the action of a nuclear gene is suppressed by the action, or by the competitive reproduction, of another plasmagene. This does not exclude the possibility that the 'sensitive' plasmagene is itself created by nuclear action.

Nine other genetic differences in five races of *Paramecium aurelia*, according to Sonneborn, show a nuclear-cytoplasmic relation similar to that of the 'killer' gene. It might not seem surprising that an incomplete subordination of the cytoplasm can survive in Protozoa or in Bacteria which have no cellular differentiation to organize. Perhaps the cytoplasm could not become the vehicle of animal development until it had largely ceased to organize heredity. A merely technical explanation is, however, sufficient. Unicellular organisms by their size, and plants by their plastids, and by the absence of such confusing elements as sex chromosomes, provide the experimental and theoretical conditions that are required for these delicate tests.

If we admit the hereditary and physiological validity of plastogenes and plasmagenes we must next look for evidence of their interaction; we must expect them to show evidence of that control of one another, mutafacient or direct, which the nucleus shows over all three levels of determinant. The fern *Scolopendrium vulgare*[14] shows such a relationship. Variegated sporophytes are pale with dark green mutant sectors. They produce two kinds of gametophyte from different whole sporangia: greens which breed true and pales which again produce variegated sporophytes, ever-sporting like the parent. Evidently there is a determinant which limits the formation of chlorophyll in the plastids. This determinant is stable in the gametophyte, but unstable in the young sporophyte. Crosses both ways between green and pale gametophytes are wholly variegated. The determinant therefore is not in the plastids. Nor is it in the nucleus, for it does not segregate at meiosis to give differences within sporangia. The determinant must be a plasmagene. Further, it must be a suppressive plasmagene since the reciprocal crosses are both of the pale type. Owing to this suppressivity even the spermatozoid is able to impress the offspring with its cytoplasmic type, and we have to admit the existence of ambilinear plasmagenes.




What does suppressivity imply? It implies that plasmagenes have rates of reproduction which can be varied widely, subject to the control of the nucleus and of one another. It implies also that their chemical equilibria must be subject in some degree to developmental as well as environmental conditions. These consequences we may now consider.

## 4. Differentiation and Mutation

The knowledge that plasmagenes can be suppressive, and hence are ambilinear, as well as mutafacient, not only raises the question of their stability or instability in development; it at once enables us to reinterpret the relevant experiments. Rogues in peas provide a starting point. They are empirically well understood[15,16]. They appear in nearly all garden varieties as more or less frequent mutations with pointed leaves and curved pods. They breed true in selfs and usually in crosses. The rogue character is therefore, like the paleness of Scolopendrium, ambilinear and suppressive in its determination. But its inheritance shows more than that. Crosses between rogues and types of the same variety give some seedlings which begin as intermediates, especially when the pollen is transmitting the rogue determinants rather than the eggs. In one variety the mutated seedlings themselves begin as intermediates which turn into full rogues before maturity. We might suppose that in these intermediate mutants and crosses the suppressiveness of rogue over type was, as in Paramecium, gradual instead of instantaneous, the unstable equilibrium being expressed in the unstable form. Breeding bears this out. The numbers of normal types in the progeny of any pod are correlated with the degree of normality of form at the level of this pod. As Bateson says, the genetic properties follow the changes of the somatic character.

Similar conditions obtain elsewhere. In rogue tomatoes suppressiveness is the other way round; type is moderately suppressive of rogue, and rogue mutation is subject to powerful environmental effects which are not yet understood[17]. But again the proportion of rogues varies with the roguishness of the plant and with the stage or state of development of any one plant. In Dahlia, Tagetes, and other Compositæ[18] breakdown of the pigmentary effector system is ambilinear in its determination, and its inheritance is correlated with its expression. But here intermediates are so stable that we cannot say that either normal or abnormal is suppressive, but only that both are slightly suppressive of the intermediate conditions. Many other analogous but more difficult cases are known[1].

If these observations have any general importance they mean that, where plasmagenes are concerned, transmission in heredity and expression in development can control one another. In doing so they are likely to defy the analytical methods appropriate to the study of either and indeed to threaten this primary boundary in biology. Already we must allow that this boundary is likely to hinder the solution of many problems now put on one side of the fence and now on the other.

It will be well, therefore, to examine other borderline cases. Among garden roses the change from the bush to the climber (not rambler) type is known in about a hundred varieties. It has the appearance of a genetic mutation. It is sudden and complete, and its occurrence is unpredictable. But its reversal is

partly predictable since the chance of reversal is greatly increased by bud-grafting on to a dwarf stock. Six out of thirty-two reverted in one budding experiment[19].

Cancer is also a border-line case on account of its heterogeneity. It ranges between two extremes. At one end it is congenital, hereditary, and highly determinate, being sometimes determined by an excess of heterochromatin[20]. At the other end it is mutational, or even invasional, and therefore inherently non-hereditary. The mutational changes may be induced in the cytoplasm of normal cells by chemical agents, the carcinogens[21], which also induce in plants dauermodifications of limited or unlimited persistence[22].

In all such cases, where the vegetative individual ceases to be the genetic unit, we have an analogy with changes that are proved to be hereditary in peas and elsewhere. How, then, are we to make the distinction between what is hereditary and what is not? Outside the nucleus it must be a physiologically trivial one. It must depend on the fact that certain self-propagating bodies, presumably nucleo-proteins in the cytoplasm, are, in one class, transmitted by the fertilized egg and, in the other class, are excluded, or liable to be excluded, from it. The distinction is physiologically trivial because, within their sphere, there are evidently different kinds of plasmagenes which vary widely in their developmental stability and selective distribution, and in their suppressiveness, or, in other words, in the type of chemical equilibrium on which they depend for their continuance.

## 5. Infection and Heredity

At this point it is worth asking how much the virus and the plasmagene have in common. In disease as well as in heredity there are three orders: nuclear, corpuscular and molecular. Viruses like plasmagenes belong to the molecular order. The chemically recognizable viruses, apart from vaccinia, chemically resemble what we know or assume of plasmagenes. They are proteins reproducing with the help of ribose nucleic acid[23], thereby being distinguished from the nuclear genes which use desoxyribose nucleic acid[24]. Viruses are subject to the developmental control of the host, being excluded from certain tissues and reduced in others. They are also subject to its nuclear control, being suppressed by some host genotypes and permitted by others, either within limits or, pathologically, without limits. There are, therefore, 'susceptible' and 'carrier' genotypes, as Baur showed in Abutilon[25]. The difference between the two types of host is genetic and may be controlled by a single nuclear gene[26]. Infection of one susceptible species can take place from another through an immune carrier species[25]. A virus, injurious to one host, can exist in equilibrium for hundreds of years with another, like the broken Zomerschoon tulip[27], damaging nothing but its chromosomes[28]. It thus becomes part of the developmental system of its host. It may be specific in its action on plastids or on pigment production, or highly generalized in its effects. It is apt to undergo mutation and consequently shows adaptation. This mutation is under the nuclear control of the host. Indeed, in the attenuation process, the nucleus is mutafacient with respect to the virus. Related viruses show suppressiveness; for example, the wild type of tobacco common-mosaic suppresses its mutants in combined infections[29]. In all these respects viruses resemble certain kinds of plasmagenes. Further, unrelated viruses may interact, and even reinforce one another, as nuclear genes do.

We are thus left with nothing to distinguish between virus and plasmagene except the two criteria used by Baur in 1906. The first is curability or environmental control as opposed to stability. But curability is rare in the absence of the antibodies produced by animals. Hot water may kill a virus without killing such a host plant as the periwinkle, for example. Similarly, Baur found that infected Abutilon, from which variegated leaves are regularly removed in a dim light, eventually produces green leaves which remain green in full light. The disease is curable.

The cure has two physiological analogies. On one hand there is chlorosis determined by nuclear genes, where the destruction of the chlorophyll likewise seems to depend on its own production: it can be stopped by low lighting, but, of course, the cure is not permanent[30]. On the other hand, there is the known environmental control of mutation or reproduction in plasmagenes. Putting the two together, we see that cure of the virus is merely the removal of the conditions of reproduction in the cell.

The second criterion is infection or invasion as opposed to inheritance. Regular transmission of viruses by the egg of the host plant (the insect vector does not concern us unless it suffers) probably does not occur, and only in a Phaseolus mosaic disease is the virus said to be transmitted by the pollen[31]. Clearly, regular inheritance of a regularly unfavourable virus, combined with infection, is an unstable condition which can end only in the whole species, either becoming adapted to carrying or resisting[31] the virus, or being extinguished by it. In the first case, the virus will have become part of the host's heredity. Both situations are found in the viruses of bacteria the rapid reproduction and adaptation of which make them observable[32].

## 6. Molecular Origins

Is there, then, between the infective virus and the inherited plasmagene an ultimate and absolute distinction? The answer is given by experiments with grafting. The transmission of viruses by grafting, confirmed as we have seen by Baur, was first noted in 1720 by Blair, who explained what he saw well enough: "'Tis by the descent of the particles from the graft, and their reascent, that the variegations appear in the other parts of the shrub"[33]. Apart from cases of variable threshold and doubtful conditioning, such as the rose mutation already quoted, a graft invasion is established in holly, privet, jasmine, laburnum and Abutilon as the cause of variegation. Now grafting is not a natural process but a human invention and a very recent and restricted one. Any virus which can be transmitted only by grafting must therefore have arisen from grafting, that is to say, from the invasion of one plant by the proteins of another.

The experimental evidence of such an expected origin of a virus is provided by the potato 'King Edward', a clonal variety, at the time of the experiments about thirty years old. The whole of this clone carries particles which, if transferred to other clones by grafting (and no other means is possible) produces

disease[34]. What is a stable and presumably useful cell protein with one plant genotype acts as a destructive agent with another. Just, in fact, as plasmagenes do.

The same principle applies to the origin of the viruses causing the Rous sarcoma[21] and presumably mammary cancer in mice. Since they are transmitted, the one only by injection, and the other only by injection or through the milk, they can scarcely have arisen otherwise than from the cell proteins of the fowl, or the mouse, in which we find them.

These viruses are distinguished from plasmagenes not by their origin or action but only by their transmission. There is therefore nothing surprising in the fact that reproductive particles can suddenly appear in the cytoplasm by the action either of the mutafacient nucleus or of external carcinogens, nor again that such particles may either be transmissible or only transplantable.

The grafting of related species of plants throws light on the position of more beneficent particles. Stocks of *Phaseolus lunatus* confer their own symbiotic specificity on scions of *P. vulgaris* and on the seedlings of these scions, and vice versa[35]. Here we have to suppose that a normal and necessary cell particle has become both infectious and hereditary, both a virus and a plasmagene, at one stroke.

The ultimate distinction between plasmagene and virus therefore seems to be the accidental one of transmission by heredity or by infection, in respect of which both are variable and both differ from their ancestral cell proteins which were used merely in development (Fig. 3). The plasmagene is a protein which can be made outside the nucleus and comes to be inherited through the egg. The virus is a similar protein which is capable of being acquired later. It is a protein which prospers through being in the wrong organism and gets there by infection[1,29]. Both classes are, of course, immensely heterogeneous. In addition, both are continually arising *de novo*, rapidly evolving, as their conditions change and partly by direct action of those conditions. They are therefore bound to diverge adaptively as they get older. But rapid divergence of the two classes merely helps to justify the supposition of their common origin.

## 7. Conclusion

Proteins in the cytoplasm can now be put in a rough genetic classification. On one hand there are some proteins, perhaps the bulk, put together by the nucleus with the help of desoxyribose nucleic acid. Perhaps, as Caspersson has suggested[24,36], the larger types of protein arise from the euchromatic genes, the smaller from the heterochromatic. And perhaps, as Pontecorvo has suggested[37], the heterochromatic genes, or polygenes of Mather, are characterized by the repetition of similar and, no doubt, simple elements. They would then be more like plasmagenes. The euchromatic genes would act by the integrated effects of dissimilar elements producing complex proteins. These proteins from the nucleus need not be self-reproducing. On the other hand, there are other proteins, plasmagenes and viruses, formed in the cytoplasm only from pre-existing proteins of similar types. These molecular types depend for their reproduction on ribose nucleic acid and are conditionally self-perpetuating. But their relative quantities are under cell control; they depend on the interaction of nucleus and cytoplasm, varying

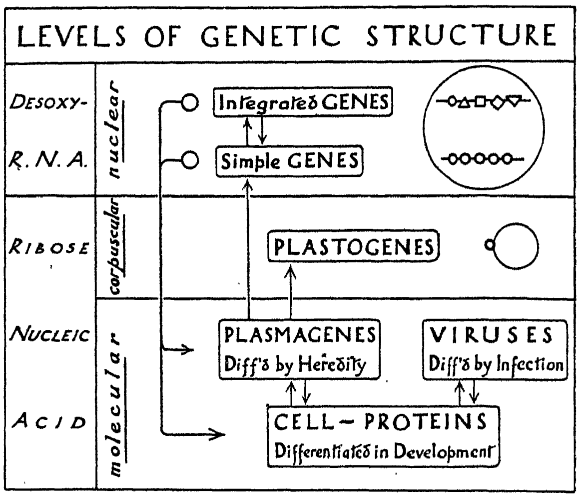



Fig. 3.

with this interaction both in heredity and development.

Between these two extremes of protein formation there are intermediate conditions where proteins, although formed by the nucleus, are potentially self-perpetuating. Their capacity for completing the life-cycle in the germ-track, and so becoming part of heredity, or for being carried by an insect, and so becoming an effective disease, will depend on suitable nuclear and cytoplasmic conditions. With limited self-perpetuation they are responsible for 'maternal inheritance' and dauermodifications.

The high frequency of plasmagene and virus mutations, aggravated by the rapidity of their selection, both under nuclear control, gives an almost Lamarckian colour to their adaptation; and in particular it accounts for their frequent and common origin from proteins in the unstable developmental zone beneath them.

To put this situation in the most general terms we must say that, at the molecular level, heredity, development and infection are under nuclear and environmental control, and that this control operates in production and reproduction, in action, in distribution, and in mutation. Further, there is interaction at the molecular level itself as shown by competition, reinforcement or suppressiveness. There is also adaptation at this molecular level and between it and the higher levels, an adaptation which obeys special rules, since mutation at the molecular level is to some extent directly determined at the nuclear level. Finally, owing to this capacity of adaptation, there is a common reservoir from which the new material of heredity and infection is continually being drawn.

The frontiers that exist between the studies of heredity, development and infection are thus technical and arbitrary, and new possibilities of analysis and experiment will arise when we have learnt the passwords to take us across them.


1 Darlington, C. D., "The Evolution of Genetic Systems" (Cambridge, 1939).
2 Schlösser, L. A., *Z. Indukt. Abst. Vererbl.*, **69**, 159 (1935).
3 Chittenden, R. J., *Bibliogr. Genet.*, **3**, 355 (1927). Pellew, C., *Biol. Rev.*, **4**, 209 (1929).
4 Mather, K., *J. Genet.*, **45**, 215 (1943).
5 East, E. M., *Genetics*, **17**, 175 (1932).
6 Renner, O., *Ber. Math.-Phys. Sächs. Akad. Wiss.*, **86**, 241 (1934).
7 Renner, O., *Cytologia*, Fujii Jub. Vol., 644 (1937).

[8] Imai, Y., *Cytologia*, Fujii Jub. Vol., 934 (1937).
[9] Rhoades, M., *Genetics*, **23**, 377 (1938).
[10] Imai, Y., *Genetics*, **13**, 544 (1928); also *Z. Indukt. Abst. Vererbl.*, **71**, 61 (1936).
[11] Pal, B. P., *Indian J. Agric. Sci.*, **11**, 170 (1941).
[12] Rhoades, M., *Proc. Nat. Acad. Sci.*, **29**, 327 (1943).
[13] Sonneborn, T. M., *Proc. Nat. Acad. Sci.*, **29**, 329 (1943).
[14] Andersson-Kottö, I., *Z. Indukt. Abst. Vererbl.*, **56**, 115 (1930).
[15] Bateson, W., *J. Genet.*, **16**, 201 (1926).
[16] Pellew, C., Verh. 5th Int. Kong. Vererb., Berlin, 1157 (1928).
[17] Crane, M. B., *Gard. Chron.*, **105**, 92 (1939).
[18] Lawrence, W. J. C., *J. Genet.*, **24**, 257 (1931).
[19] Crane, M. B., and Lawrence, W. J. C., "Genetics of Garden Plants", 2nd Ed. (London, 1937).
[20] Darlington, C. D., and Thomas, P. T., *Proc. Roy. Soc.*, B, **130**, 127 (1941).
[21] Haddow, A., *Nature* (in the Press).
[22] Levan, A., and Östergren, G., *Hereditas*, **29**, 381 (1943).
[23] Hoagland, C. L., *Ann. Rev. Biochem.*, **12**, 615 (1943).
[24] Darlington, C. D., *Nature*, **149**, 66 (1942).
[25] Baur, E., *Ber. Dtsch. Bot. Ges.*, **24**, 416 (1906).
[26] Cadman, C. H., *J. Genet.*, **44**, 33 (1942).
[27] Cayley, D. M., *Ann. Appl. Biol.*, **19**, 153 (1932).
[28] Upcott, M. B., *J. Genet.*, **34**, 392 (1939).
[29] McKinney, H. H., Proc. 7th Int. Genet. Cong., Edinburgh, 200 (1940).
[30] Darlington, C. D., *J. Genet.*, **21**, 161 (1929).
[31] Reddick, D., 2e. Cong. Int. Path. Comp., Paris, 1, 363 (1931).
[32] Delbrück, M., "Advances in Enzymology" (2), 1 (1942).
[33] Blair, Patrick, "Botanick Essays" (London, 1720).
[34] Salaman, R. N., and Le Pelley, R. H., *Proc. Roy. Soc.*, B, **106**, 140 (1930).
[35] Hoffmann, F. W., *J. Agric. Res.*, **34**, 673 (1927).
[36] Caspersson, T., *Naturwiss.*, **29**, 33 (1941).
[37] Pontecorvo, G., *Nature*, **153**, 365 (1944).


# PEBBLES OF REGULAR SHAPE, AND THEIR REPRODUCTION IN EXPERIMENT*

By the RIGHT HON. LORD RAYLEIGH, F.R.S.

MOST pebbles are of irregular shape; for example, in the glacial beds of flint pebbles near my home in Essex, at the most two per cent have any symmetry, and the presumption is that the large majority have not been worn down long enough or far enough to acquire it. We shall leave the irregular majority aside and deal only with those that have symmetry.

A pebble may fairly be called regular if it has three planes of symmetry at right angles to one another, but in fact most of the points of interest are exemplified by the more limited class that have circular symmetry. Such a pebble can be described by a familiar terminology, using the terms axis, poles, equator, latitude, as we use them for the earth.

As I have said, my own home is in a district where gravel beds of flint, washed out from the chalk, are abundant. A collection of such flint pebbles range from prolate to oblate forms. If a good sphere could be found, it would fill up the series very satisfactorily, but no sphere of the right size has been found. Spheres are occasionally met with, but they are much too large to fit into this series. I shall return to them presently.

From a geometrical point of view, the simplest generalization of a sphere is the spheroid, with the meridional section an ellipse, and it is natural to regard that as the typical form for a circular pebble. So long as the pebble is not too much elongated or shortened in the axial direction, we may be sure on general geometrical grounds that we shall not be far wrong in describing it as a spheroid. This hypothesis is not put to a severe test unless the polar dimensions differ considerably from the equatorial; but in such cases we find that the description as a spheroid is altogether wide of the mark. The more extreme forms are very far from being elliptical in outline. The prolate form is rather a cylinder with rounded ends, and the oblate a disk with rounded edges. That is what we find in natural pebbles.

It is not always possible to imitate Nature's operations in the laboratory—sometimes the scale is too large, and sometimes the time required would be prohibitive. This case, however, is comparatively favourable. It would take a long time to produce rounded pebbles of so hard a material as flint, but one gets on very much faster with marble, which is homogeneous and in other respects suitable. In Nature, flint is usually abraded by flint, but in my experimental work marble is not abraded with marble, but with hard steel—fragments of old files broken up for the purpose. In this way we get on still quicker, and the result is the same. What shape should we begin with? If we begin with pieces altogether irregular, a great deal of material has to be removed before a symmetrical shape is attained. This process is tedious and not particularly instructive. I have therefore begun with square prisms elongated or flattened according to whether it was desired to produce a prolate or an oblate pebble. The marble prism is put in a metal container with pieces of hard steel, and a little water as a lubricant further to imitate natural conditions. The whole is kept in slow rotation for a few days, when the marble is found to be quite rounded, the series of shapes corresponding very closely to that of the natural pebbles. The flattened disk and the round-ended cylinder appear as before, the intermediate shapes being nearer the spheroidal. A cubical block does not give a very good sphere when abraded in this way, and it has been found that there is little or no tendency for a pebble of nearly spherical form to get nearer to the sphere, so long as the process of abrasion is by churning up with other fragments—as, for example, when gravel is rolled along in water-courses.

Nevertheless, there are spherical flints found in Nature, particularly in the 'Cannon Shot Gravels' of Norfolk, which afford spherical balls two or three inches in diameter. These, I understand, are in commercial demand for use in ball mills. Such spherical flints are not thought to be shaped in Nature by attrition, for similar balls are sometimes found *in situ* in the chalk, under conditions which make it obvious that the mass as formed by chemical precipitation was spherical from the first.

Although the flattened pebbles which have been mentioned are typically found in most deposits which contain any pebbles of symmetrical shape, yet pebbles of much better approximation to a spheroid are not unknown. One or two, that I owe to Sir D'Arcy Thompson, are unfortunately of uncertain origin, but they are believed to come from mountain torrents, and this raises the question whether we can find any artificial process which will yield pebbles exactly spheroidal. I have made a number of experiments to imitate the kind of action which may be supposed to take place in mountain water-courses, in which the pebbles are whirled and tossed on a rocky bed. A cylindrical metal vessel full of water has on the bottom an abrasive bed, made of Portland cement mixed with carborundum grit. The block of marble

* Substance of a discourse at the Royal Institution delivered on March 3.

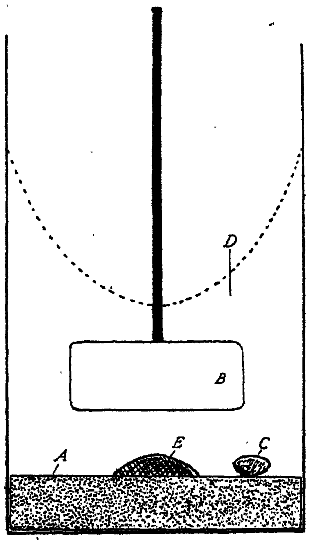



Fig. 1.

is placed on this and a violent vortex motion is maintained by a paddle driven by an electric motor (Fig. 1). The block of marble turns and rolls and skips on the abrasive bed, and in the course of three or four days it is reduced to a smooth pebble of a shape very nearly spheroidal. It differs from the spheroid in this, that instead of bulging out at intermediate latitudes like the ordinary circular pebbles, it slightly shrinks in, and may be described as lying inside the spheroid instead of outside. Clearly then, a combination of the two processes might give a very close approximation to the spheroid, and naturally occurring spheroidal pebbles may thus be accounted for.

This leads, by a natural sequence of ideas, to the consideration of pebbles worn down in potholes. Potholes, as is generally known, are cylindrical holes which are formed in the rocky beds of water-courses. They are bored out by pebbles which are carried round and round by the swirling water. They are often a foot or so in diameter and of comparable depth, but may be very much larger. I have only had limited opportunities of examining them. The pebbles found in such holes are often quite irregular. There are, however, some pretty accurately spherical pebbles preserved in the Dunn Collection, in the Mineral Department of the British Museum (Natural History), which have probably been formed in potholes, and I have been led to a laboratory study of this process. A hollow cylinder of carborundum cement was used, instead of the flat disk above-mentioned, and in this case, to save time, a lump of marble roughly spherical was used to start with. The vortex was maintained as before by a revolving paddle. The marble lump went round and round on the bottom, pressing laterally against the abrasive wall.

Let us now digress for a short time to consider how a somewhat elongated body, pivoted about its centre, will behave in a current of water. The natural man is generally inclined to say that it will set itself along the current. It is difficult to see why this conclusion seems the most natural. No doubt, if the elongated body were pivoted near one end, it would point with the longer length down-stream; but that does not help us to say what it will do if pivoted at the middle. The stream impinging on the solid body must divide and go partly to one side and partly to the other. In the case of an oblique lamina, the place of division will be somewhat upstream of the pivot. The pressure is greatest where the velocity is least, namely, at the point of division, and the pressure there will have a moment tending to set the lamina across the stream. Fig. 2, showing stream lines drawn according to theoretical hydrodynamics, will illustrate this point, though it must not be taken to represent what really happens on the down-stream side of the lamina. Moreover, it is not enough to consider only the point of maximum pressure, though this gives some insight into the matter, enough perhaps for our present purpose.

Let us now return to the lump of marble going round and round in the vortex on the bottom of the cylindrical vessel. Obviously, the stone will to some extent be retarded by friction on the bottom, and the stream of water may be regarded as passing over it, though not with the full velocity. There will then be a tendency for the stone to set itself across the (circumferential) stream, that is, radially to the vessel. Thus the longest dimension of the stone will set itself radially in the vessel, and the centrifugal force will press it against the vertical abrasive wall. The longest dimension will be continually worn down. Clearly, the stone should continually approach the spherical form; and this is what does, in fact, happen. Fairly good spheres can be made in this way. As the exact spherical form is approached, the directive couple becomes continually less. When the maximum diameter is only about three per cent in excess of the minimum, there is not much further improvement, accidental disturbances presumably being too great for the directive action to overcome. However, spherical pebbles of this degree of accuracy are equal to the very best natural spherical pebbles that I have seen, which are probably of pothole origin. Nothing so good seems to occur in any gravel deposits, though owing to present conditions there is no access to the beaches on the south coast.

Some attention has been devoted to concave pebbles. These sometimes originate in a concave fracture of flint, but it is as a rule fairly easy to distinguish such cases. There are concave pebbles which do not appear to originate in this way, and they have been imitated experimentally in marble. The same general method of experimenting was used as in the experiments first described; that is, by placing the specimen, in this case a flat parallel piece, in a metal container with the abrasive and keeping it in slow rotation, with a little water as a lubricant.

A powdered abrasive like carborundum grit or sand

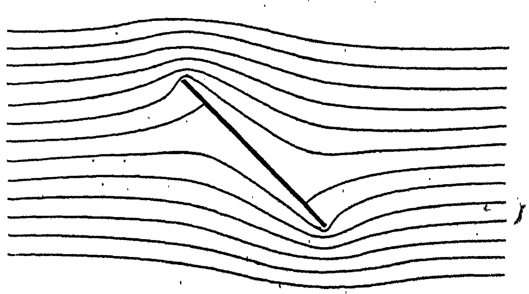


Fig. 2.

never develops a concave surface on the stone. For that, it is necessary to use an abrasive of large pieces comparable with the marble specimen itself (3 cm.). Broken flints serve very well and are easy to get. If we put a dozen such in a box with a square slab of marble, the edges and corner of the marble are, of course, rounded, but the large faces become concave.

Another instructive experiment on this subject is to use instead of marble a square of plate glass. If this is abraded in the rotating container with carborundum powder, the edges alone are pitted. This is the initial stage of the ordinary process of forming a rounded pebble. If, on the other hand, we put the glass in the revolving box with a number of sharp flints of size comparable with its own, the sharp edges have chips broken off them, which process represents the first stage of rounding the edge. In addition, we find pitting on the flat polished surface, and these pittings are more concentrated at the middle than at the edges; clearly showing the early stages of the development of a concavity.

With the view of analysing this effect, the experiment was repeated using a single flint only instead of many, and for a longer period, so that the aggregate number of pittings might be comparable. In contrast, these pittings were now found to be uniformly distributed, so that in this case no concave curvature is produced. It can scarcely be doubted that the stones other than the one which is actually operative act as a shield, and are more likely to screen the outside than the middle of the glass. In this way concavity is produced.

## WATER SUPPLIES IN GREAT BRITAIN AND THEIR UTILIZATION

A JOINT meeting of the Geological Society and the Institution of Water Engineers was held on April 19, under the chairmanship of Prof. W. G. Fearnsides, to discuss "Water in Relation to Town and Country Planning". As proposed by the chairman in his introduction, the meeting was mainly confined to a consideration of sources of water and their relation to development in Great Britain. The meeting attracted a notable attendance and produced a vigorous discussion. In addition to Prof. Fearnsides and Mr. S. R. Raffety, chairman of the Institution of Water Engineers, who briefly introduced the discussion on behalf of the water engineers, there were fifteen other speakers. They covered a wide range of topics which will be considered in order, though it may be noted at the outset that many of the outstanding aspects were indicated by Prof. P. G. H. Boswell in a well-considered opening on behalf of the geologists.

The vital dependence of populations and industry alike on water supply was inevitably stressed by many speakers. In earlier times no centre of habitation could develop unless water was obviously at hand, but now that it appears from pipes and taps the relation is overlooked with amazing frequency. Apart from their head waters, nearly all streams in Great Britain are polluted beyond any possibility of direct use for domestic and for most industrial purposes. Yet the increasing population must spread, and in certain cases industries must move, largely to areas where local surface supplies are quite unavailable. Hence underground water becomes increasingly important. Prof. Fearnsides gave an apt illustration from the Yorkshire coalfield. The growing exhaustion of the coals in the western part of the field compels the industry and population to move increasingly eastward to the coals buried under the Trias plain. The underground Trias water has been excellent, but growing demand has led to over-pumping; mining fractures the overlying rocks, and the combined result in some cases is the drawing in of water from the underlying Permian or even from the Coal Measures, with great deterioration in quality, as well as actual or threatened insufficiency.

Prof. Boswell particularly stressed the point that industrial requirements continue to increase to such a degree that a single large works may use as much water as a fair-sized town. Many instances of consequent serious difficulty have occurred, and he indicated that industrialists are very grateful for early information regarding the actual condition in areas under consideration. While the geologist may be able to give a fair assessment of a 'virgin' area, great uncertainty may be attached to some already industrialized areas where, though underground water is certainly prolific, there is complete absence of any systematic record of the heavy draughts already made. Mr. H. P. Hill, besides supporting the general theme by reference to the dependence of the older industrial areas of Lancashire and Yorkshire on the head waters of the Pennine rivers, added the valuable point that a substantial proportion of those head waters have long been impounded for the supply of canals which are now disused or decadent. Some of this water could now be used for supply.

Much of the discussion naturally ranged around the question of alternatives when adequate supplies of pure water are not available in the neighbourhood. For the really great centres of population the ultimate solution (with the notable exception of London) has almost inevitably been the use of remote upland waters. But for any smaller centres the cost of such lengthy aqueducts is forbidding. London's great contribution to the problem has been the demonstration that even highly polluted river-water may be rendered particularly pure and distributed by pumping at reasonable economic rates. It certainly points the way to one possible line of advance in certain cases. In his opening comments on the growing south-east Yorkshire towns, Prof. Fearnsides made the interesting suggestion that they may have to resort to constructing reservoirs on the middle courses of the Ouse tributaries, while Prof. W. S. Boulton (in the course of a written contribution) referred to the very considerable areas of the eastern and southern Midlands with little underground water and very variable sluggish rivers. He likewise suggested a substantial development of low-level reservoirs in such areas.

Mr. R. C. S. Walters particularly emphasized the point made by several speakers that great quantities of pure and relatively costly water are wasted, quoting the extreme case of its use for quenching gas-works coke. Like others, he commented on the danger and difficulties of 'dual' supplies of water, but hoped that the engineer might overcome it. In this connexion the use of mine water was considerably debated. Prof. Boulton referred to its extensive use for the supply of canals in the Midlands, and he had investigated its possibility for the many million

gallons required by the cooling towers of the electric stations of the national grid. Unfortunately, many analyses proved it too corrosive, and several speakers quoted similar experience in attempts to promote its industrial use. This prevailing conclusion, however, should not obscure the fact that there are industrial uses for which it would serve; nor the quite different circumstance that some mines take and contaminate good water from strata overlying the Coal Measures, which could be kept separate and utilized, as is actually done in the case of large volumes of Magnesian Limestone water tapped by certain mines in Durham.

Prof. Boulton's ultimate proposal for the cooling-tower problem was the use of purified sewage effluent, of which Birmingham provides more than 20 million gallons per day. This principle may yet be carried much further. The question of sewage control and purification is quite inseparable from the whole question of water supply in several ways. In Mr. Raffety's opening he referred to the large increase in the volume of sewage water in one area which resulted from the building-up of an adjoining district. Rainfall which formerly soaked into the land and fed the underground supplies was led into sewers, contaminated, taken away and lost for supply. In large urban areas this leads to a great reduction of underground resources. A later speaker directed attention to the fact that many important wells and boreholes are in the vicinity of rivers, and the underground waters on which they draw are liable to contamination by the polluted streams. There is no reason now why all substantial sewage should not be so treated as to produce a practically pure water. The fact that the cost of treatment cannot be immediately offset by a corresponding profit entry loses all force when weighed against the immeasurable gain to the community in amenities of all kinds, and not least in the protection of its water supplies.

The question of protection was another main theme of the discussion. Mr. R. C. S. Walters demonstrated by the cases of several of the Coventry wells that the area of intake of the underground water may be immediately around the well or in some more or less remote area in particular cases. He emphasized the need for precise geological knowledge of each case to define the region where protection from surface pollution is necessary. Dr. Buchan illustrated the pollution of the underground supplies which has resulted from the over-pumping in certain parts of east London drawing in salt water from the estuary. Prof. Boswell noted the depletion of considerable areas which results from mine drainage, and Mr. Edmunds the loss from the uncontrolled flow of artesian supplies.

Dr. G. M. Lees quoted his experience of recharging Persian oil-wells with temporary surplus petroleum, which had proved entirely successful, and suggested the replenishment of water supplies from the chalk by leading the excess of pure water available during periods of plenty into suitable disused wells. Though other speakers referred to cases in which attempts had failed, the idea seems worthy of further investigation.

Regarding the important question of water-borne disease, Mr. Raffety noted that while concern is properly felt for the safety of underground supplies in urban areas, the majority of proved cases of epidemics arising from polluted water have concerned supplies from rural sources. Mr. E. Morton observed that while the large undertakers can afford to purchase substantial areas of land or otherwise protect their sources, the smaller rural companies have not this facility. The ever-present danger of unrestricted private pumping is widely felt, and attention was directed to the unknown but probably very considerable remote effects of the concentrated pumping of such prolific areas as the Colne and Lea valleys.

The need for investigation and for the proper recording of all supplies was naturally uppermost in the minds of many speakers. All dwelt on the incompleteness of most records (making them of little value) and the extreme lack of information regarding private supplies. Mr. Edmunds commented on the special value of long-period records and on the unfounded fears which have frequently prevented disclosure of information. Dr. Buchan also gave an admirably illustrated account of some of the more recent studies of underground water-levels by the Geological Survey, extending over a wider area his well-known studies of the London region, and indicating the importance of such collated knowledge for the correct assessment of the water resources in any area.

Prof. W. B. R. King discussed the fundamental importance of systematically planned research on selected areas, including continuous rainfall and water-level data, percolation and run-off gauging, behaviour of exhaustion cones, and investigation of rock characteristics in the field and laboratory. Much might be done by the co-operation of university departments with neighbouring water authorities. Some of the work would be necessarily expensive and funds would be needed.

Sir Malcolm Watson directed attention to a matter of first-class importance in stressing the need of adequate supplies of water for agriculture. Mr. C. Green spoke especially of the part played by finance as the final deciding factor in all water schemes, and the essential ground for Government intervention.

Finally, Mr. C. E. N. Bromehead referred to some recently discovered and quite unexplained anomalies in the iodine content of certain supplies. Though the iodine amounts only to some 50 parts per thousand million, this is about seventeen times the normal, and the occurrences represent a medically important and geologically puzzling problem.

While the meeting did not proceed to the framing of formal resolutions, the vital importance of a comprehensive survey of the water resources of Great Britain, both surface and underground, was made clearly evident; as also the fact that such a survey cannot be satisfactorily complete or just unless it be made under statutory powers. Urgent demand has compelled the great cities to use their large financial resources to solve the water problem, usually by resort to long-distance impounding schemes. Hence the outstanding problems relate chiefly to 'rural' areas and widely spread industrial regions, to which such schemes cannot as a rule be economically applied. For this reason underground waters acquire an ever-increasing importance, and the time is overdue for the Government to accept responsibility for the control of water supply. Water supply must be one of the foremost considerations in every scheme of town and country planning. Uncontrolled competition for water cannot be tolerated, whether among private concerns or public companies. It can have only the most harmful results, and it reflects most seriously on those responsible for the orderly development of the country.

# OBITUARIES

## Prof. A. H. Reginald Buller, F.R.S.

ARTHUR HENRY REGINALD BULLER was born in Birmingham on August 19, 1874. His biological training included work at Mason College, Birmingham, at Leipzig, Munich, and (in 1900) at the Marine Biological Station, Naples. He then returned to Birmingham as lecturer in botany until, in 1904, he was appointed first professor of botany in the University of Manitoba.

The young and booming city of Winnipeg delighted Prof. Buller, and the cold, bracing winters suited him. He entered with enthusiasm and energy upon his teaching, which at first included geology as well as botany. He prepared all his lectures and laboratory courses with great care, and transmitted something of his scientific spirit to his students. He did much, with the few other faculty members, to promote the growth of the young University.

At night during the long winters, and in any free time by day, he devoted himself to researches on the fungi. With painstaking, persistent care, and with much ingenuity in the use of simple apparatus, he sought out the details of such activities as the production, liberation, and dispersion of spores in Coprinus and other fungi. Few could lose themselves so completely in their work as he; but, since he never married and always lived at a hotel, the missing of a meal or a night's sleep disturbed no one.

One of the attractions of the position at Manitoba was the long summer holiday which allowed him to spend three or four months each year at Birmingham, where he worked in the laboratories or library, or studied Nature in the woods and fields, commonly with his friend W. B. Grove. In later years he spent much of each holiday at Kew.

Although Buller had published several papers in scientific journals, by 1909 he had enough material for a book to be entitled "Researches on Fungi". He submitted his manuscript to a society, but was told it could not be published unless it were reduced by about half. That, he considered, would be mutilation. He therefore published the book at his own expense—and later five more volumes even larger. Many mycologists and others have found this *magnum opus* not only of great scientific value, but also eminently readable. Other books included "Essays on Wheat" and a "Practical Botany" for students.

On returning to Winnipeg each year about the end of September, he started his classes and then took advantage of the usually glorious Canadian autumns for a few mycological forays. Alone or with students, and later with members of the mycological colony which gathered at Winnipeg, he went for one or a few days into the primeval woods at Kenora or Minaki. He was a most stimulating leader of such excursions, for he knew not only the names but also the habits of the larger fungi and was always ready to spend an hour or two, even in heavy rain, to discover any new detail.

Prof. Buller gradually built up a strong department of botany and, though there was no graduate school for several years, he helped train a number of mycologists and other men of science now prominent in Canada. He took great interest in the Dominion Laboratory of Plant Pathology, which began at Winnipeg in 1923. He was always ready to help any co-worker.

Many honours came to him, including the presidency of the British Mycological Society, of the Botanical Society of America, and of the Royal Society of Canada. He was awarded the LL.D. by the Universities of Manitoba and of Saskatchewan, and a D.Sc. by Pennsylvania. He was elected a fellow of the Royal Society in 1929, and awarded a Royal Medal in 1937. His popularity as a lecturer increased through the years, and he was frequently chosen to give important lectures or lecture courses in Canada and the United States.

Buller's interests were broad. He knew by sight most of the flowering plants of England and of Manitoba, and many of the birds. He read much, and had memorized long passages from Milton and Shakespeare. He amused himself by writing verse (some of his limericks have international fame), by playing the piano, by conversation—preferably regarding fungi, but with interest on any subject. He listed his recreations as "billiards and crossing the Atlantic" and, though he found little time for the former, he made about sixty-five trans-Atlantic journeys (surely a record for a botanist). He had assumed, when he became professor emeritus at Manitoba in 1936, that his Atlantic crossings would end on an even number. However, the outbreak of war caught him at a congress in New York, so he returned to his researches at Winnipeg, varied with a number of lecture trips. In Winnipeg—which, after all, had been his main home for forty years—he developed a tumour on the brain which entailed weeks of hopeless struggle, and caused him worry because all his planned researches were not completed. He died on July 3, 1944, and is survived by a sister in London.

G. R. BISBY.

## Prof. A. E. Conrady

ALEXANDER EUGEN CONRADY was born at Burshied, Düsseldorf, on January 27, 1866. His death in London on June 16, 1944, removes one who has taken a very prominent part in the development of optical sciences in Great Britain, of which he became a naturalized subject in 1903.

His father, Edmund Conrady, ultimately left the profession of schoolmaster to manage a firm which had its business centre in Bradford, England, but A. E. Conrady's first visit to England took place while he was still an undergraduate at the University of Bonn, and later he also had occasion to travel to various parts of the world in the capacity of engineering adviser. He seems early to have developed a great interest in the design and production of lens systems, and in the early 1890's he set up in business at Keighley as "Optician and Mechanician". Somewhat later he received great assistance and encouragement from Mr. George William Brown of Leeds, with whom he entered into partnership under the name of Eugen Conrady and Co., with premises in Park Street, Camden Town. During this period he designed and began to produce the microscope objectives known as the "Holoscopic" Series, which were considered at that time to be unsurpassed in definition. He had also designed and produced a convertible anastigmatic photographic lens of aperture *f*/6·3, followed by others.

In 1898 Conrady began his long association with Messrs. W. Watson and Sons, Ltd., as chief designer and scientific adviser. The "Holoscopic" systems were and still are produced by this firm, for which

he designed many other notable systems, including a range of apochromatic objectives. During the War of 1914–18 it was early found that all the periscopes used in British submarines had been obtained from a foreign firm and that no British maker had experience of their design and manufacture; but Conrady produced very successful designs for this essential instrument and superintended the subsequent production, thus helping materially to avoid a very grave peril.

The Department of Technical Optics was founded at the Imperial College of Science and Technology in 1917 to meet the urgent need of training more optical designers for British firms, and Conrady was appointed to the chair of optical design on the strong recommendation of the late Prof. F. J. Cheshire. Conrady's first class was a summer vacation course, attended by a large number of enthusiastic students including a Senior Wrangler. Freed from the immediate pressure of an industrial post, Conrady's unrivalled practical experience flowered into original and strikingly simple treatments of optical theory.

Conrady had already had contributions to the theory of optical design published in papers in the *Monthly Notices of the Royal Astronomical Society* during 1904–5, and had thus indicated already that the main feature of his work would be the application of physical optical principles in this field. He was greatly influenced by the work of the late Lord Rayleigh, and coined the now familiar term 'Rayleigh limit' to denote the '$\lambda/4$' maximum allowable optical path difference characteristic of a good design. He worked out the relations between geometrical and physical expressions of aberration, and showed how to control the residual aberrations. A series of papers which appeared in the *Monthly Notices* during 1918–20 reflect something of the fertility of his ideas, which were, however, treated much more fully in the typed lecture notes issued to students. His well-known book, "Applied Optics and Optical Design" (Oxford University Press, 1929), was the result of many trials and experiments in presentation. His work has placed the whole subject of optical design on a far stronger basis than was previously obtainable.

Beyond the material contained in the first book, he had given, in his lectures to advanced students, more extensive material on the systematic design of microscope objectives and a new treatment of aberration theory based on considerations of optical path. It was hoped that after his retirement from the Imperial College in 1931, he would have leisure to complete this material for a second volume, but ill-health unfortunately frustrated him. The hope has been widely expressed that since some members of his family are distinguished in the fields of physics and optical design, they will be able to edit and publish the very full notes which he left.

Conrady was never happier than when lecturing to his students, emphasizing special points with a shake of the upraised forefinger. He had a keen sense of fun and humour, and he enjoyed and told many a good story. Fond of the open air, his favourite holiday frequently took the form of an extended trip with his family up the Thames in a rowing boat. He was, however, extremely shy and sensitive, shrinking instinctively from controversy.

His activity of mind made him seem somewhat inattentive to parallel work carried out by others. Faced by a question, he found it easier to obtain the answer from his own research than by reference to published literature, and indeed his writings are remarkable for their scarcity of references to investigations published by other writers. He might have been happier if his temperament had allowed him more readily to tolerate controversy and criticism, but on his retirement he withdrew completely into privacy, partly owing to indifferent health. He had lectured before the Royal Institution, and had received the Traill-Taylor Medal of the Royal Photographic Society; and it is pleasant to record that shortly before his death he was made an emeritus professor of the Imperial College of Science and Technology. But if honours were comparatively few, his most notable honour is the gratitude of many students to whom he opened paths which would otherwise have been impassable. His passing will be much to the regret of students and former colleagues.

In 1901 he married Annie, the fourth daughter of William and Mary Bunney of Harefield, who died in 1941. He is survived by three daughters.

L. C. MARTIN.

## Dr. Milan Hodža

DR. MILAN HODŽA, the Czechoslovak scholar and former statesman, died in Florida on June 27 at the age of sixty-six. The son of a Protestant pastor, Hodža was born at Sučany, in north Slovakia, in 1878 and graduated at Budapest. Circumstances led him to champion the cause of his Slovak kinsmen, whom he represented in the Hungarian parliament during 1905–14. He was imprisoned during the War of 1914–18, but when the Czechoslovak Republic was founded his advancement was rapid. Indeed, he was almost continuously in the Cabinet either as Minister of Agriculture or Education and lastly as Premier during 1935–38.

Hodža was responsible for many progressive educational measures and for various social advances such as the radical land reform in Czechoslovakia. In education, his policy was to neglect no section of the community, and to utilize the nation's resources to the financial limit. This involved the erection, equipping and staffing of thousands of new elementary and secondary schools, and the establishment of two new universities, besides various scientific institutes and research stations. In agriculture he realized the importance of the need for greater application of scientific knowledge for improved crop cultivation and stock-breeding, and he also did much to promote international co-operation among agriculturists.

His premiership coincided with critical years for his country, and when its independence was lost he went first to France, then to England and finally to the United States, where his last years were spent in writing his "Federation in Central Europe", in which he outlined a scheme for a federal co-operation among the Danubian States.

G. DRUCE.

WE regret to announce the following deaths:

Sir Ralph Fowler, O.B.E., F.R.S., Plummer professor of applied mathematics in the University of Cambridge, on July 30, aged fifty-five.

Mr. F. J. Mortimer, C.B.E., a former president of the Royal Photographic Society and editor of several photographic journals, recently by enemy action, aged sixty-eight.

# NEWS and VIEWS

## Electrical Engineering at Birmingham: Prof. D. M. Robinson

THE chair of electrical engineering at the University of Birmingham has been filled by the appointment of Dr. Denis M. Robinson. Prof. Robinson, who is in his fortieth year, graduated as B.Sc.(Eng.) at King's College, London, in 1928; he was awarded the degree of Ph.D. of London in 1930, and had industrial training at Siemens and Metropolitan-Vickers. During 1929–31 he was a research student at Massachusetts Institute of Technology, publishing a paper on "Unpolarised Resistivity of Glass". During 1931–35 he held a research appointment with Callender's Cables, Ltd., his work being published in 1935 as a monograph entitled "High Voltage Cables". Later he held a research appointment in television engineering, an experience which led to his being taken into the Air Ministry in December 1939, where he is working in the Tele-communication Research Establishment. His service, which involves frequent visits to the United States, has been connected with developments of new discoveries and the putting of these into production. He has thus been brought into contact with all the important electrical engineering firms controlling new developments. Prof. Robinson is therefore exceptionally qualified to effect the union of fundamental advances in physics with the established branches of electrical engineering.

## Bank of England Trust Fund for Research in Economics

To mark the two hundred and fiftieth anniversary of the founding of the Bank of England, the Court of Directors has decided to establish a trust fund with a capital of £100,000 for the promotion of economic research. The fund will be known as the Houblon-Norman Fund, after Sir John Houblon, the first governor of the Bank in 1694, and Mr. Montagu Norman, who retired recently after holding the office of governor for twenty-four years. The income of the fund will be used to award fellowships, probably three a year, to be known as Houblon-Norman Fellowships, for the promotion of research into the working and function of financial and business institutions in Great Britain and elsewhere and the economic conditions affecting them. Grants may also be made toward the expenses of research already in being and to facilitate publication.

Although the Bank of England will follow with interest the activities of the trust, the management of the trust will be independent of the Bank, the first trustees being the deputy governor (Mr. B. G. Catterns), Lord Eustace Percy and Mr. Samuel Courtauld. In making awards the trustees will be assisted by an expert committee, the first members of which will be Mr. Henry Clay, warden-elect of Nuffield College, Oxford, economic adviser to the Bank of England, and previously professor of social economics in the University of Manchester; Sir Hubert Henderson, recently elected professor of political economy in the University of Oxford, now serving as economic adviser to his Majesty's Treasury; and Prof. A. M. Carr-Saunders, director of the London School of Economics and formerly professor of social science in the University of Liverpool. The trustees will announce in due course when they are open to receive applications for fellowships.

## Distribution of Spindle (*Euonymus europaeus*) in Great Britain

THE Biology War Committee has been requested by the Agricultural Research Council to collect information and afterwards to plan sample surveys of the distribution of the spindle tree (*Euonymus europaeus*) in Great Britain. This scheme is part of the general research programme into the biology of the bean aphis (*Aphis fabæ* (*A. rumicis*)) which over-winters on this plant. The damage done by the bean aphis to the sugar-beet crop alone is estimated to reach a million pounds in some seasons, and proper knowledge of the distribution of its primary winter host is essential in any consideration of the problems of control. The Committee therefore asks for the following information from anyone able to supply it: (1) The exact location (reference one inch or six inch map if possible) of areas which can be put in the following categories: (i) spindle totally absent; (ii) spindle rare or occasional (isolated bushes 1–2 plants per square mile); (iii) spindle frequent (intermediate density between (ii) and (iv)); (iv) spindle unusually abundant (at least a hundred bushes per acre or ten plants per 100 yards of hedgerow); (data for *Euonymus* spp. in gardens should not be included). (2) The proportion by area which falls into each of the four foregoing categories of density. (3) The differences in (*a*) geological formation, (*b*) soil, (*c*) drainage, (*d*) altitude, (*e*) aspect, (*f*) other factors, which might influence the distribution of spindle. Such information should be sent before August 31 to Mr. G. E. Blackman, Hon. Secretary, Biology War Committee, Imperial College of Science and Technology, London, S.W.7.

## Scientific Books and Papers for China

THROUGH the Cultural Scientific Mission to China of the British Council, British men of science have learned of the great difficulties under which their Chinese colleagues are labouring to-day. Of the many obstacles to the pursuit of science in war-time China, not the least important is the scarcity of standard text- and reference books, and journals and reprints, which, equally with technical apparatus, are necessary for scientific teaching and research. The Natural Science Society of China (British Branch), through its president, Dr. S. P. Chu, and honorary secretary, Mr. P. M. Yap, is appealing for scientific and technological publications, which readers of *Nature*, either individually, or as organizations, can spare, to be sent to China. The great majority of Chinese scientific workers are accustomed to English texts and literature; indeed, many of them have obtained a part or the whole of their training in Great Britain, and the response to this appeal will be of significance, not merely as an expression of comradeship between British and Chinese scientific workers, but also as a constructive effort towards rehabilitating science in Free China. The British Council, 3 Hanover Street, London, W.1, has offered to receive on behalf of the Society such scientific literature as may be available; and it will be dispatched as opportunity offers to the Science Library of the Natural Science Society of China in Chungking.

## Determination of Distance by Radio

THE issues of the *Journal of the Franklin Institute* of January and February 1944 contain an article by C. D. Tuska entitled "Historical Notes on the Determination of Distance by Timed Radio Waves". This

article traces the historical development of methods of measuring distance by means of radio waves using both the frequency modulation and amplitude modulation or pulse methods. It is now about twenty years since the classical experiments of Appleton and Barnett provided a direct measurement of the height of the reflecting layer in the ionosphere using the frequency variation method; while, shortly afterwards, Breit and Ture demonstrated the use of short trains of waves of about one millisecond in length for making the same type of measurement. Many variations and improvements on these two methods have been made from time to time by those engaged in studying the properties of the ionosphere as a medium for reflecting radio waves back to the earth's surface. Methods based on the same principles have also been used for determining the altitude of aeroplanes by reflecting waves from the ground beneath. The article referred to above describes briefly the various methods which have been devised to meet these applications by the aid of a review of the published scientific literature, and especially of the publications of the United States Patent Office for the past ten years or so. As the author states, the notes are necessarily incomplete for the war period, on account of the scarcity of publications for security reasons. The bibliography of eighty-one references appended to the article may, however, be useful to those concerned with tracing the historical development of a comparatively modern application of radio science.

## Institute of Ophthalmology at the Royal Eye Hospital

THE immense clinical material and the considerable research activities at the Royal Eye Hospital have prompted the Council of the Hospital to initiate the establishment of an Institute of Ophthalmology, where teaching and research can be carried out systematically and co-ordinated with the work of laboratories and of other ophthalmic and of general hospitals. The Institute will have an independent Board of Governors; and panels of scientific, medical, surgical and ophthalmic advisers have been set up to help in planning and carrying out the work. The Institute will be open to all ophthalmologists, and offers of co-operation will be welcomed.

## Beit Memorial Fellowships for Medical Research

THE following elections have been made to Beit Memorial Fellowships for Medical Research, with permission for each fellow to be seconded at any time for war duties: *Fourth Year Fellowships* (£500 a year): Dr. W. Holmes, to continue the study of the regeneration of nerve fibres after injury (Department of Zoology and Comparative Anatomy, University Museum, Oxford); Dr. Mary F. Lockett, to continue the study of renal pressor substances responsible for experimental high blood pressure (Pharmacology Laboratory, Cambridge). *Junior Fellowships* (£400 a year): Dr. J. C. Boursnell, to study the fate and functions of trace and some other elements in the animal body, using radioactive isotopes (Department of Biochemistry and Chemistry, Medical College of St. Bartholomew's Hospital); Dr. G. A. Levvy, to study the adaptive enzymes in the animal body with special reference to the role of glucuronidase in the metabolism of steroid hormones and related substances (Department of Biochemistry, University of Edinburgh); Dr. H. J. Rogers, to study the biochemistry of hyaluronidase obtained from various sources, and the role of enzymes such as hyaluronidase and lecithinase and other bacterial antigens in infection (Lister Institute, Elstree, Herts); Dr. G. J. Romanes, to study the relationship between the developing mesoderm and the motor apparatus of the spinal cord supplying it (Department of Anatomy, University of Cambridge); Dr. F. Sanger, to study the chemical structure of proteins with special reference to insulin (Sir William Dunn Institute of Biochemistry, Cambridge); Miss S. P. V. Sherlock, to study the hepatic function in disease by biopsy methods (Department of Medicine, British Postgraduate Medical School); Dr. Charity Waymouth, to study the factors influencing tissue growth *in vitro* (Physiology Department, University of Aberdeen); Mr. E. C. Webb, to study the ultimate mode of action of drugs and poisons in living tissues (Sir William Dunn Institute of Biochemistry, Cambridge).

The Trustees, in their annual report for the year 1943–44, refer to the election this year of Prof. G. F. Marrian, professor of biochemistry in the University of Edinburgh (fellow 1917–20), to the fellowship of the Royal Society. They accepted with great regret the resignation of Prof. T. R. Elliott, who has been secretary to the Advisory Board since 1930, and whose experience and wisdom had been of inestimable value; his place on the Board has been taken by Sir Thomas Lewis, and Dr. A. N. Drury, director of the Lister Institute, has been appointed acting secretary.

## Announcements

DR. NORMAN ALLEN, of the Research and Development Laboratory of the Mond Nickel Company, Ltd., has been appointed superintendent of the Metallurgy Division at the National Physical Laboratory. He will take up his duties on September 1, 1944.

THE honorary degree of doctor of science has been conferred by Columbia University, New York, on Dr. L. J. Briggs, director of the U.S. Bureau of Standards, and Te-Pang Hou, who was trained first in China and afterwards in the United States, and eventually established in China a modern chemical work.

THE Royal Institution has established nine graduate memberships, three of which will be awarded annually to recent graduates, of either sex, of any university in the British Empire who have taken a degree with either first or second class honours in any scientific subject. The membership will give the holder the full privileges of members of the Royal Institution for a period of three years, with the exception of the right to attend or vote at any meeting of the members. The first three graduate memberships will be awarded about November 1944 to students who have graduated in 1944. Application forms can be obtained from the General Secretary, Royal Institution, 21 Albemarle Street, London, W.1.

ERRATUM. In the communication "'Fluorine-like' Action of Various Substances on the Teeth" by Prof. J. T. Irving, in *Nature* of July 29, last paragraph but one (p. 150), line 17, the word "not" should be omitted, and the phrase should read ". . . the other substances here examined also act only by altering the composition of the blood . . ."

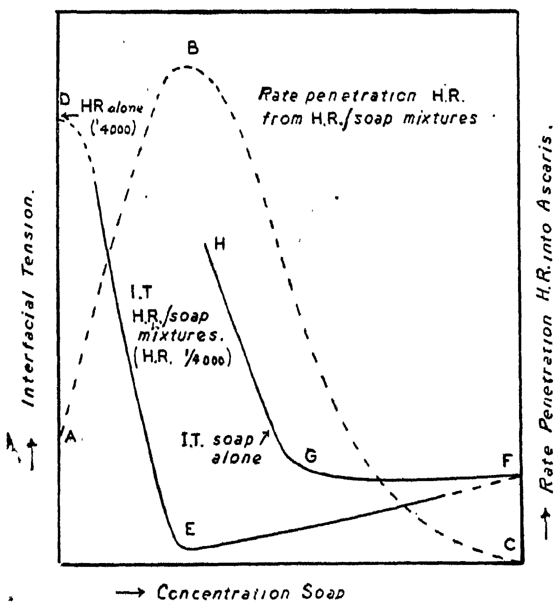
# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Effect of Soaps and Synthetic Wetting Agents upon the Biological Activity of Phenols

AN investigation into the anthelmintic action of hexyl resorcinol, in particular as modified by the presence of soaps, leads us to suggest a simple and apparently general explanation of the numerous, often contradictory, results previously recorded upon the biological activity of soap/phenol systems. (The term 'soap' here covers both the natural soaps and the synthetic detergents.)

Measurements of the rate of penetration of hexyl resorcinol into the pig roundworm, *Ascaris lumbricoides* var. *suis*, alone and in the presence of soaps (sodium cholate, sodium oleate and cetyl trimethyl ammonium bromide) have been carried out, and in addition measurements, under parallel conditions, of interfacial tension against an inert mineral oil ('Nujol'). A similar behaviour is shown with all three soaps and is illustrated diagrammatically in the accompanying figure.




Considering a fixed concentration of hexyl resorcinol (for example, 1/4,000), the principal points can be enumerated as follows: (*a*) On increasing the soap concentration from zero, the biological activity, as measured by the rate of penetration into Ascaris, rises from its initial value $A$ to a *maximum* at $B$. (*b*) Over this range of soap concentrations, the interfacial tension falls to a *minimum* at $E$. (*c*) The maximum accelerating effect of the soap, as indicated by the difference between $B$ and $A$, is in the order cholate $\ll$ oleate $<$ cetyl trimethyl ammonium bromide. (*d*) The maximum lowering of the interfacial tension (at $E$) is also in the order cholate $\ll$ oleate $<$ cetyl trimethyl ammonium bromide. (*e*) The minimum interfacial tension of the hexyl resorcinol/soap mixture is markedly lower than that of either of its constituents, indicating 'complex' formation in the interface[1]. (*f*) With increase of soap concentration beyond that corresponding to $B$ (or $E$), the biological activity falls to zero ($BC$ in figure). (*g*) Over this range of soap concentration, the interfacial tension rises ($EF$ in figure), ultimately reaching a value which approximates to that of the soap alone. (*h*) The critical concentration for micelle formation is lowered by the presence of hexyl resorcinol (from $G$ to $E$ in the figure).

It is clear that the rate of penetration of hexyl resorcinol is intimately related to the interfacial activity of the soap/hexyl resorcinol mixture, thus readily accounting for the part $AB$. As the soap concentration is increased beyond that corresponding to $B$ (or $E$), the interfacial tension curve shows that micellar aggregation sets in, and the hexyl resorcinol, being present in fixed amount, will distribute itself between the micelles and any other interface present (for example, oil/water or Ascaris/water), thus tending to raise the interfacial tension and hence to *diminish* the rate of penetration. Further increase in the soap concentration will increase the proportion present in the micellar form, until ultimately effectively all the hexyl resorcinol is held by the soap micelles, the mixture consequently showing negligible reduction of interfacial tension from the value for the soap alone (point $F$), and also negligible biological activity (point $C$). (The soaps alone penetrate Ascaris comparatively slowly, if at all.)

This simple picture of a competition between micelles and biological interface should be of general validity not only for all types of phenols but also for other biologically important compounds when present in aqueous soap solutions (for example, in certain insecticidal sprays, and possibly also in fat absorption). Whether the soap is already present in the system (for example, as bile salt or fatty acid), or is added intentionally, is immaterial.

Examination of the literature shows many phenomena which appear to be explicable upon this simple picture. For example, Frobisher[2], studying the activity of phenol/soap mixtures against *B. typhosus*, found an optimum soap concentration. (His explanation for the inhibition by the higher soap concentrations—a coating of the bacteria surface with a more or less solid soap film acting as a protective covering—must be ruled out in the light of more recent surface chemical concepts.) Billard and Dieulafe[3] showed that the toxic effect of curare injected into guinea pigs intraperitoneally could be accelerated by the addition of low concentrations of soaps but decreased by higher concentrations. Bellows and Gutmann[4] showed enhanced penetration of sulpha drugs into the cornea in the presence of certain detergents. There are also numerous recorded cases of the *decrease* of the bactericidal activity of phenols by soaps[5], which likewise are readily explicable on the above principles.

Concerning the ultimate origin of this enhanced biological activity of hexyl resorcinol and other phenols in the presence of suitable concentrations of soap, various possibilities have to be considered. For example, the phenol may penetrate by a normal diffusion process, the greater surface activity of the complex serving merely to increase the concentration at the biological interface; or it may penetrate by means of a two-dimensional interfacial spreading[6], the diffusing unit now being the soap/phenol complex. On either picture the acceleration should run parallel with the interfacial activity, as found experimentally

(c and d above). The fact that soaps penetrate Ascaris slowly, if at all, even under the optimal conditions for penetration by hexyl resorcinol, would appear to discount the latter; but the whole question is necessarily complex and warrants a more detailed discussion than space permits here.

The results outlined above, to be detailed in a forthcoming publication, emphasize the importance of 'complex' formation in biological activity, as shown earlier by Schulman and Rideal[1] in their study of hæmolysis and agglutination.

A. R. TRIM.
Biochemical Laboratory,
A. E. ALEXANDER.
Colloid Science Department,
Cambridge.
June 6.

[1] Schulman and Rideal, *Proc. Roy. Soc.*, B, **122**, 29 and 46 (1937).
[2] Frobisher, *J. Bact.*, **13**, 163 (1927).
[3] Billard and Dieulafe, *C.R. Soc. Biol.*, **56**, 146 (1904).
[4] Bellows and Gutmann, *Arch. Ophthalmology*, **30**, 312 (1943) (available in abstract only *C.A.* **38**, 791 (2)).
[5] For example, Tilley and Schaffer, *J. Infect. Diseases*, **37**, 359 (1925). Hampil, *J. Bact.*, **16**, 287 (1928).
[6] Rideal, *Trans. Faraday Soc.*, **33**, 1081 (1937). Hurst, *Trans. Faraday Soc.*, **39**, 390 (1943).

## Formation of Aluminium Hydride Layers on Aluminium

SCHULLER and his co-workers[1,2] have shown, from spectroscopic studies by the hollow-cathode technique, that hydrogen molecules forming the aluminium hydride bands come from the metal itself. I had come to a similar but more definite conclusion some time earlier, and had observed that hydrogen molecules formed a layer of aluminium hydride spaced between the well-known aluminium oxide layer at the surface and metallic aluminium underneath.

The following is an account of my recent experiments. An aluminium plate as cut from ordinary sheet aluminium and a carbon rod formed the electrodes and potassium hydroxide solution the electrolyte. The carbon rod was kept in the solution and afterwards the aluminium electrode was quickly introduced and the ensuing voltages noted. In one set of observations, when a normal solution of potassium hydroxide was used, the voltage immediately came to 0·8, rose to 1·254 in two minutes and a half, fell to 1·2 in three minutes and a half, and then remained constant except for a small decrease due to polarization.

The voltages of 0·8 and 1·2 clearly correspond to aluminium oxide and pure aluminium respectively, measured with respect, of course, to carbon, the latter voltage appearing when all the upper layers have been consumed by chemical action. The voltage 1·254 is then due to a layer which is neither of the two. On the theory of oxidation-reduction potentials, or even on prior considerations, it is clear that the layer must be a compound of aluminium of a more reducing character than aluminium.

It is presumably aluminium hydride. The following observations confirm the above findings. The cathode giving 1·2 volts, corresponding to the state of pure aluminium, was taken out, dried with a cloth with nearly uniform pressure, exposed to air and was re-inserted in the cell. The nature and magnitude of voltages obtained depended upon time of exposure to air and are given in the accompanying table.

| Time of exposure | Succeeding voltages |
|---|---|
| 1 minute | 1·22 → 1·2 |
| 5 minutes | 1·23 → 1·2 |
| 15 ,, | 0·9 → 1·238 → 1·2 |
| 35 ,, | 0·85 → 1·247 → 1·2 |

The results clearly show the process of formation of the two layers and that the new layer is formed first, the oxide layer forming some time between 5 and 15 minutes of exposure.

If the plate on exposure was also washed with water and then dried with a cloth, the layers were formed much more quickly, which of course shows the deterrent action of the film of potassium hydroxide retained on the aluminium electrode in the absence of washing, in delaying the formation of the layer in virtue of its chemical activity.

In the present method, the lower layers are brought to the surface by the chemical destruction of the upper, which are then shown by their potentials.

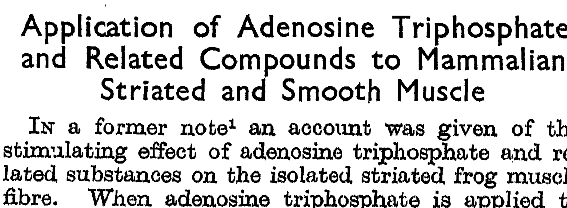
I thank Profs. J. B. Seth and D. M. Bose for the experimental facilities provided.

RAM PARSHAD.
Irrigation Research Institute,
Lahore.
Feb. 2.

[1] Schuller, Gallnow and Haber, *Z. Phys.*, **111**, 7, 508 (1939).
[2] Schuller, Gallnow and Fechner, *Ann. Phys.*, **31**, 328 (1939).

## Application of Adenosine Triphosphate and Related Compounds to Mammalian Striated and Smooth Muscle

IN a former note[1] an account was given of the stimulating effect of adenosine triphosphate and related substances on the isolated striated frog muscle fibre. When adenosine triphosphate is applied to *striated mammalian muscle* (m. tib. ant. of the decerebrated cat) by close arterial injection[2] in amounts of 0·05–0·53 mgm. per gm. muscle ($1·46–14·6 \times 10^{-6}$ mol./ml. = $0·1–1·0 \times 10^{-6}$ mol./gm. muscle) a rapid, tetanic contraction is released which is accompanied by interfering electrical activity (see accompanying record). Threshold dose and mechanical response are identical in non-curarized and curarized preparations, the effect of total curarization being insured by inexcitability of the sciatic nerve towards maximal stimuli and by insensitiveness of the muscle to intra-arterial injection of 50 μgm. acetylcholine. Intra-arterial injection of 5 μgm. acetylcholine after previous treatment of the non-curarized preparation with adenosine triphosphate releases a mechanical response with a considerably longer duration and higher tension than the same dose of acetylcholine does to a muscle without previous application of adenosine triphosphate.



MECHANICAL RESPONSE AND ACTION POTENTIALS OF M. TIBIALIS ANT. (CAT) AFTER CLOSE ARTERIAL INJECTION OF $0·6 \times 10^{-6}$ MOL. ADENOSINE TRIPHOSPHATE PER GM. MUSCLE.

Adenosine diphosphate ($1 \cdot 7$–$7 \cdot 0 \times 10^{-6}$ mol./ml. = $0 \cdot 12$–$0 \cdot 5 \times 10^{-6}$ mol./gm. muscle) likewise initiates tetanic contractions. Adenylic acid ($2 \cdot 6$–$8 \cdot 1 \times 10^{-6}$ mol./ml. = $0 \cdot 2$–$0 \cdot 6 \times 10^{-6}$ mol./gm. muscle) has stimulating effects on the non-curarized preparation, while the curarized muscle only reacts slightly or not at all. Inorganic sodium triphosphate ($2$–$12 \times 10^{-6}$ mol./ml. = $0 \cdot 15$–$0 \cdot 9 \times 10^{-6}$ mol./gm. muscle) and sodium pyrophosphate ($2 \cdot 5$–$17 \times 10^{-6}$ mol./gm. muscle) release tetanic contractions in curarized and non-curarized muscle, while inorganic sodium orthophosphate in amounts of $20 \times 10^{-6}$ mol./ml. ($= 1 \cdot 7 \times 10^{-6}$ mol./gm. muscle) is ineffective.

All chemical stimuli were applied iso-osmotically by replacing a corresponding amount of sodium chloride in the Thyrode solution with the substances in question; *p*H of the solution was 7·3.

When applied to *smooth muscle* (stomach and bladder of the cat by intra-arterial injection, and small intestines of the guinea pig by adding the substance to the surrounding Ringer bath) *only adenosine triphosphate initiates strong activity*. The threshold dose is approximately $0 \cdot 3 \times 10^{-6}$ mol./ml. ($= 0 \cdot 04 \times 10^{-6}$ mol./gm. muscle). The atropinized preparation which is insensitive to strong doses of acetylcholine still reacts to adenosine triphosphate. Adenosine diphosphate ($2 \cdot 5 \times 10^{-6}$ mol./ml. = $0 \cdot 35 \times 10^{-6}$ mol./gm. muscle), adenosine diphosphate plus orthophosphate ($5 \cdot 0 + 5 \cdot 0 \times 10^{-6}$ mol./ml. = $0 \cdot 7 + 0 \cdot 7 \times 10^{-6}$ mol./gm. muscle), adenylic acid ($2 \times 10^{-6}$ mol./ml. = $0 \cdot 26 \times 10^{-6}$ mol./gm. muscle), inorganic sodium pyrophosphate ($7 \times 10^{-6}$ mol./ml. = $1 \cdot 0 \times 10^{-6}$ mol./gm. muscle) and sodium orthophosphate ($14 \times 10^{-6}$ mol./ml. = $2 \cdot 0 \times 10^{-6}$ mol./gm. muscle) are completely ineffective on the stomach and the bladder of the cat, while pyrophosphate causes contractions in the small intestines of the guinea pig ($0 \cdot 22$–$0 \cdot 7 \times 10^{-6}$ mol./ml.). The effect of inorganic triphosphate ($6 \times 10^{-6}$ mol./ml. = $0 \cdot 83 \times 10^{-6}$ mol./gm. muscle) is either absent or slight. Thus the action of adenosine triphosphate on smooth muscle is highly specific and corresponds to its specific effect on the flow birefringence of purified myosin solutions[3].

These experiments support the view that adenosine triphosphate is an essential agent in the release of normal muscular contraction.

FRITZ BUCHTHAL.
GEORG KAHLSON.

Department of Physiology,
University of Lund.
June 6.

[1] Buchthal, F., Deutsch, A., and Knappeis, G. G. [*Nature*, 153, 774 (1944)].

[2] Brown, G. L., *J. Physiol.*, 92, 22 P (1938).

[3] Needham, J., Shih-Chang Shen, Needham, D. M., and Lawrence, A. S. C., *Nature*, 147, 766 (1941). Needham, J., Kleinzeller, A., Miall, M., Dainty, M., Needham, D. M., and Lawrence, A. S. C., *Nature*, 150, 46 (1942).

## Fortification of Pasteurized Cheese with Fish Liver Oils

A SYSTEMATIC search for natural foods that could be fortified with crude fish liver oils in order to supplement the vitamin A content of diets for native troops resulted in peanut-butter containing 5,000 I.U. of vitamin A per ounce being produced in large quantities. The peanut-butter masks the fishy flavours of the crudest fish liver oil, while the added vitamin has been demonstrated to be stable for six to nine months at high temperatures (85°–98° F.).

Continuing the above systematic search, the possibility of fortifying pasteurized cheese with crude fish liver oils has been investigated during the past year. Stonebass (*Polyprion americanus*) liver oil of 610,000 I.U. of vitamin A per gram, diluted with arachis oil to 80,000 I.U. of vitamin A per gram, stockfish (*Merlucius capensis*) liver oil of 9,370 I.U. of vitamin A per gram and Vaalhaai shark (*Galeorhinus canis*) liver oil of 26,800 I.U. of vitamin A per gram were added to cheese during the last stages of the pasteurizing process and thoroughly mixed. The degree of fortification aimed at in these experiments was 5,000 I.U. of vitamin A per ounce of cheese. The fortified pasteurized cheese was packed either in A 2½ cans and hermetically sealed or in standard ounce packages wrapped in tinfoil. The fortified cheese was stored at room temperatures and at constant temperatures of 85°–98° F.

Vitamin A in the cheese was determined by the Carr-Price reaction after ether extraction of the unsaponifiable fraction followed by removal of the ether. Losses of vitamin A during saponification, as indicated by Jones and Haines[1], suggest that the recovery values of 77–80 per cent of the vitamin added to the cheese are lower than the actual values. In no case could more than 90 per cent of the added vitamin A be recovered with the utmost precautions and refinements in the method of estimation. Some loss of vitamin A is thus expected in the process of fortification.

Losses of vitamin A during storage for 8–12 months at 85° F. proved to be less than 10 per cent. Cheese in ounce packages wrapped in tinfoil maintained its vitamin content just as well as cheese packed in hermetically sealed tins.

Only in the case when stockfish liver oil was added (amounting to 2 per cent of the cheese) could any suggestion of fishy flavour be detected, and then only by comparison with control samples.

The feasibility of fortifying pasteurized cheese with crude fish liver oils has thus been demonstrated. Crude liver oils of vitamin A potency ranging from 15,000 to 80,000 I.U. per gram would appear to be most satisfactory. The lower potency oils, such as stockfish liver oils, have to be added in such quantities that the consistency of the cheese is appreciably changed, although at no stage was any sign of fat separation from the emulsion visible.

REES DAVIES.
E. BEYERS.

Low Temperature Research Laboratory,
Cape Town.
March 27.

[1] Jones, J. I. M., and Haines, R. T., *The Analyst*, 68, 8 (1943).

## Role of Protozoa in the Aerobic Purification of Sewage

DURING recent years, there has been increasing amount of evidence regarding the importance of protozoa in the aerobic purification of sewage[1–4] and, more recently, some quantitative observations on protozoa in determining the condition of sludge and quality of effluent have been recorded[5–10]. The evidence so far obtained has, however, been only indirect, chiefly owing to the difficulty in separating

the protozoa from the associated bacteria. This has now been achieved and the object of this note is to show that the isolated protozoa can bring about practically all the changes associated with the purification. The part played by the bacteria is almost negligible.

We isolated the protozoa (Epistylis sp.) by first washing a part of the mucilaginous masses (adhering to the sides of the activation sludge tank) repeatedly on the centrifuge with the necessary precautions. A few living cells were then selected after microscopic examination. They were inoculated into vessels containing a sterilized, thin decoction of fæcal matter and vigorously aerated. After the sludge was built up, a fresh careful selection of cells was made. This operation was repeated a number of times until the associated bacteria (usually mechanically carried on the mucilage) were eliminated and the medium consisted exclusively of the active protozoa. The protozoa required fresh quantities of organic matter, together with liberal supplies of air, and so long as these were provided, there was no difficulty in maintaining them in an active condition.

That the isolated protozoa are at least as active as the normal activated sludge in the purification of sewage is shown by the following comparative study with sterilized raw sewage.

COMPOSITION OF THE EFFLUENT OBTAINED AFTER AERATION FOR 24 HOURS (IN PARTS PER 100,000).

| | Raw sewage at start (control) | Activated sludge | Protozoa (*Epistylis* sp.) | Mixed bacteria |
|---|---|---|---|---|
| Oxygen absorbed from permanganate in 3 min. | 1·87 | 0·26 | 0·21 | 1·23 |
| ,, in 4 hours | 4·16 | 0·51 | 0·41 | 3·95 |
| Free and saline ammonia | 2·46 | 0·62 | 0·57 | 1·98 |
| Albuminoid ammonia | 1·02 | 0·20 | 0·12 | 1·00 |

Further evidence is available to show that the conditions affecting the life and activity of the protozoa also affect the efficiency of the purification. There is practically no sludge formation or clarification when (*a*) the medium is selectively heated to about 50° C. so as to inactivate or kill the protozoa; (*b*) partial sterilizing agents (dyes such as methylene blue and acridine yellow which act selectively on protozoa) are introduced; (*c*) Chironomus larvæ which primarily destroy the protozoa are introduced; (*d*) fermenting yeasts, which are inimical to the protozoa, are added. The necessity for steady addition of fresh organic matter and also adequate aeration—both of which are essential to the protozoa—are too well known to require repetition.

Examination of sludges from activated sludge and other aerobic systems of treatment from various parts of India have revealed the presence and active functioning of protozoa wherever the purification is proceeding satisfactorily. If the protozoa are absent or found dead or encysted, there is no purification.

Starting from the investigations of Russell and Hutchinson on soil sickness and partial sterilization of soil[11], there has been a general tendency to regard protozoa as being inimical to the useful aerobic bacteria and aerobic processes in general. The earlier observations of Fowler and other workers[12-15] in the field of aerobic purification of sewage also pointed in the same direction. Evidence on the other side has, however, been steadily accumulating, so that with these and the conclusive evidence now reported, it can be stated that aerobic purification of sewage is essentially due to the protozoan activity. Bacteria play only a secondary part.

Further evidence on the phenomenon of flocculation by protozoa has already been adduced by other workers. Hardin[16] has recently demonstrated the flocculating activity on the part of the ubiquitous freshwater and soil flagellate, *Oikomonas termo* Kent. Watson[17] has recorded that the soil ciliate, *Balantiophorus minutus*, shows a similar ability to cause flocculation to that reported for *Oikomonas termo* and for Epistylis and Vorticella.

There are still some outstanding problems such as the mechanism of flocculation by protozoa and their exact role in the production of sludge having a high fertilizing value and in the related oxidation changes. These and related aspects are now being studied and will form the subjects of later communications.

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April 29.

[1] Richards, E. H., and Sawyer, G. C., *J. Soc. Chem. Ind.*, **41**, 62T (1922).
[2] Cramer, R., *Ind. and Eng. Chem.*, **23**, 309 (1931).
[3] Ardern, A., and Lockett, W. T., *Proc. Inst. Sew. Purif.*, 1 (1936).
[4] Baritt, N. W., *Ann. Appl. Biol.*, **27**, 151 (1940).
[5] Pillai, S. C., *Current Sci.*, **10**, 84 (1941).
[6] Pillai, S. C., *Indian Med. Gazette*, **77**, 118 (1942).
[7] Pillai, S. C., *Current Sci.*, **11**, 437 (1942).
[8] Reynoldson, T. B., *Nature*, **149**, 608 (1942).
[9] Pillai, S. C., and Subrahmanyan, V., *Nature*, **150**, 525 (1942).
[10] Pillai, S. C., and Subrahmanyan, V., *Science and Culture*, **8**, 376 (1943).
[11] Russell, E. J., and Hutchinson, H. B., *J. Agric. Sci.*, **3**, 111 (1909).
[12] Fowler, G. J., *J. Inst. Sanit. Eng.*, **20**, 29, 39 (1916).
[13] Fowler, G. J., *J. Soc. Chem. Ind.*, **41**, 72T (1922).
[14] Fairbrother, T. H., and Renshaw, A., *J. Soc. Chem. Ind.*, **41**, 134T (1922).
[15] Jenkins, S. H., *Nature*, **150**, 607 (1942).
[16] Hardin, G., *Nature*, **151**, 642 (1943).
[17] Watson, J. M., *Nature*, **152**, 693 (1943).

## Pelage Change of the Stoat, *Mustela erminea* L.

IN 1942[1], I published an account of the change of pelage in the stoat, *Mustela erminea* L. The whitening of the coat in three out of five captive stoats was attributed to exposure to cold, although this factor did not seem to affect the commencement of the moult itself.

Prof. T. H. Bissonnette, who was working on the pelage change of weasels, very kindly sent me his then unpublished data with many valuable suggestions. He considered it possible that the change to white was only an indirect result of the cold, produced by the animal's loss of activity and consequent curtailment of its own daylight by longer periods spent in the sleeping boxes. He has since published[2] his own experiments with Bonaparte's weasel (*M. cicognanii cicognanii* Bonaparte) and the New York weasel (*M. frenata noveboracensis* (Emmons) ). In the case of the former he shows conclusively that the change of pelage, both with regard to moult and whitening, could be controlled by manipulation of the light-cycle. In the latter species the moult was similarly controlled; but the colour change involved only a change to light brown and not to white. Farther north, in the wild, this weasel (at least the female) turns white in winter.

The War has unfortunately interfered with my own experiments, but the following observations seem worth recording.

In 1942[1], I stated that "captive stoats have two moults". Since then I have found two specimens which moulted twice during the winter. It is inadvisable to handle these animals frequently as some risk of injury to themselves is always involved. It is, therefore, very easy to overlook the first winter (or autumn) moult, which is from brown to brown, and indeed it seems probable that this oversight has occurred where other specimens are concerned. I had previously noted[1] that in my captive stoats the white pelage was carried for three to four months only, but that judging from museum skins, wild stoats in Scotland remained white for much longer periods. In the case of the former a colour change was involved in only one winter pelage; but it is possible that two successive moults may be white under the conditions prevailing in Scotland. Bissonnette found that his captive Bonaparte weasels could be induced to moult from white to white.

Although considerable variation occurs between individuals, and also from year to year in the same specimen, the order of the moult is similar to that described by Bissonnette for both species of weasels. Winter moults begin on the underneath of the belly and sweep up the legs, tail (distal portion first) and sides of the body. The top of the head and a narrow line down the neck and centre of the back are the last portions to turn white. In the spring moults the process is reversed, and the brown hairs grow in first on the head and along the middle of the back. The tip of the tail, of course, remains black throughout.

Even if the winter moult does not involve whitening, the brown coat is slightly lighter in colour than the summer coat. The hairs on the belly are also less strongly tinged with yellow, although not pure white.

Experimental reduction of daylight was carried out with five captive stoats. It was found that by sudden or gradual shortening of the hours of daylight, additional moults could be induced in the spring and summer, but none of these moults involved a colour change. In one male stoat only, a few white hairs appeared on the feet and legs. This specimen had never previously changed colour. Afterwards it retained these white hairs throughout all moults over a period of two years.

Stoats which were subjected to gradual but drastic light reductions during the critical periods of the winter moults also did not change colour. One of the stoats in question had made a partial change to white in each of the two previous winters when exposed, during a period of sixty-three days, to thirty-four and forty-four days of temperatures below 32° F. However, this stoat did not change colour at all under warmer conditions, despite curtailment of the hours of daylight. It was subjected to only twelve days of temperatures below 32° F. The increased hours of darkness commenced on September 21 and on December 21 culminated in a three-week period, in which five hours of daylight alternated with thirty-six hours of darkness.

It will thus be seen that with regard to whitening of the pelage, *M. erminea* is far less susceptible than *M. cicognanii* to the effect of light reduction alone. This factor apparently plays a subsidiary part in the colour change of the British species. It does seem likely, however, as Prof. Bissonnette suggests, that reduction of temperature involves a change of habit which brings about a natural reduction of the light cycle and perhaps loss of activity, and that these factors play a complementary role in producing both moult and colour change. It would be extremely interesting to know if the New York weasel (*M. frenata*) could be induced to whiten if subjected to low temperatures in addition to reduced hours of daylight which induce only a moult to paler brown. It seems clear that the response to the different factors governing pelage changes varies greatly, not only from individual to individual and at different times of the individual's life, but also from species to species.

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June 11.

[1] Rothschild, M., *Nature*, 149, 78 (1942).

[2] Bissonnette, T. H., *Trans. New York Acad. Sci.*, 5, Ser. II, No. 3, 43 (1943).

## An Unusual Host for a Polypore

IN December 1943 through the kindness of Dr. K. P. Biswas, superintendent of the Lloyd Botanical Gardens of Darjeeling, I obtained a few specimens of green leaflets of a Macrozamia sp. from the Darjeeling garden bearing tiny fructifications of *Polystictus sanguineus* (Linn.) May. on their back surface (see accompanying illustration). Sections of the fructifications showed normal basidia and white and oval spores (4–6 × 3–4 mic.) of *P. sanguineus*. In sections of leaflets under the microscope partial disintegration of chloroplastids at places and formation of tannin drops were detected though the leaflets were quite green to the naked eye.

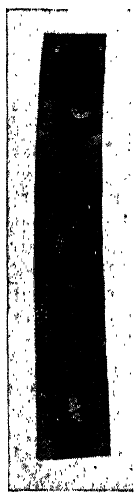

FIG. 1. FRUCTIFICATION OF *P. sanguineus*.

So far, I have not come across any mention of a polypore fruiting on green leaves of higher plants—an apparent parasitic habit; by correspondence (March 9, 1944) with Dr. L. O. Overholts of the Pennsylvania State College I learn that he also has no such experience. Thus, this may be recorded as the smallest polypore yet known.

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## The Pisiform Bone

PROF. H. A. HARRIS's[1] rediscovery of the secondary centre of ossification in the pisiform confirms the work of Retterer[2], who found it in cat, dog and rabbit, and Sieglbauer[3], who found it in chimpanzee, gorilla, Tarsius, Stenops and Macacus. But his conclusions from its "hitherto unsuspected existence" are scarcely justifiable, for there is no reason for believing that secondary centres are a prerogative of one type of skeletal element. His letter does raise the question of what criteria can be used to determine whether a bone is a sesamoid.

Sesamoids appear where tendons of muscles turn over bony prominences, and have one surface cartilage-covered to glide over the prominence, separated by a synovial cavity, while the other

surface is embedded in the tendon. The synovial cavity is usually an extension of the cavity of the neighbouring joint, but may be (for example, peroneus longus) a part of a synovial bursa. Sesamoids appear first as mesenchymal condensations of the tissues between the developing tendons and prominences[4]; the deeper parts are always developed in cartilage, but the part embedded in the muscle may be formed of calcified tendon substance later replaced by lamellar bone. Historically, sesamoids are unknown in all carboniferous and Permian animals, and have never been developed in the lines leading to the modern urodeles, turtles, crocodiles or Sphenodon, but have been developed by independent evolution in several other groups[5].

The essential factor for the development of a sesamoid is the pressure of a bony prominence, so that the tendon is exposed to lateral pressure at the same time as it is stretched. Some sesamoids may increase the leverage of muscles, but their removal does not greatly affect muscular power. Probably they are concerned rather with the maintenance of the vascular supply of the tendon in the region where the blood vessels would otherwise be liable to prolonged occlusion by lateral pressure. In this they are analogous to the ossified tendons found in several dinosaurs, birds and kangaroos[6].

Sesamoids can usually be recognized from their positions and relationships, but sometimes special criteria must be used. The pisiform does not articulate with a single bony prominence in most animals, but fills the gap between the ulna and ulnare; and even when, with increasing freedom of ulnar deviation at the wrist it comes to articulate with the ulnare (triquetral) alone, it does not glide over this bone as a sesamoid should, and its synovial cavity is a separate formation. It is, as many authors have indicated, constantly present in all early reptiles and is indicated in the amphibian Eryops and so cannot be a sesamoid[7,8]. The patella, on the other hand, to take another bone the morphology of which has been questioned, is a sesamoid because it has the typical structure, position and relationships, it is exposed to pressure as it turns over the lower end of the femur, and it is not developed in primitive tetrapods. Harris's criterion, the presence of a secondary centre, already discussed at length by Sieglbauer[3], is of doubtful value in recent forms, and is useless in early forms as no secondary centres appear before the Triassic.

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[1] Harris, H. A., *Nature*, **153**, 715 (1944).
[2] Retterer, Ed., *C.R. Soc. Biol., Paris*, x, 5, 435 (1898).
[3] Sieglbauer, F., *Wien. klin. Wochr.*, **44**, 832 (1931).
[4] Nauck, E. T., *Morph. Jb.*, **72**, 567 (1933).
[5] Haines, R. W., *J. Anat. Lond.*, **75**, 101 (1940).
[6] Koch, W., *Anat. Anz.*, **62**, 138 (1927).
[7] Gregory, W. K., Miner, R. W., and Noble, G. K., *Bull. Amer. Mus. Nat. Hist.*, **48**, 279 (1923).
[8] Gillies, C. D., *J. Anat. Lond.*, **63**, 380 (1929).

IN a recent letter in *Nature*, Prof. Harris[1] gave radiological evidence for the appearance of a separate epiphysial centre in the pisiform bone of sub-human primates. In view of the considerable theoretical importance which he attached to this finding, further observations have been made in this Department. A number of female Rhesus monkeys of accurately known age were available for X-ray study. The result of this investigation has been a smooth and continuous record of the developing pisiform bone in the macaque monkey from birth to maturity.

Examination of the individual films shows that in the female macaque the centre for the body of the pisiform is already present at birth. It is well marked at the age of four months and has attained almost adult size and shape at 16½ months, at which age, however, there is no trace yet of a secondary, epiphysial centre. But the latter is clearly present at the 20½ months, 22½ months stage and still later, at 36 months, although by that time the thickness of the epiphysial cartilage appears much reduced. At the age of six years the Rhesus monkey no longer possesses a radiologically demonstrable epiphysis, and fusion must have taken place during the intervening time.

Thus the existence of a separate epiphysial centre in the pisiform of macaques has been amply confirmed. In addition, the 'life-span' of this centre has now been more clearly defined for, as shown above, it makes its first appearance between the ages of 16½ and 20½ months and fuses with the main centre between three and six years.

Many workers in the past have studied the morphological significance of the pisiform bone, but the literature shows that no uniformity of opinion has yet been reached. The view that it corresponds either to the whole of the os calcis or only to its tubercular part has been expressed before, mainly by the older school of comparative anatomists such as Lavocat[2], Albrecht[3], Baur[4], von Bardeleben[5] and, more specifically, by Ed. Retterer[6]. This worker, after demonstrating the existence of two separate bony centres for the pisiform of the rabbit, cat and dog, concluded in 1898: "Ce mode de développement et la texture du pisiforme adulte m'ont porté à considérer ce segment comme un os long ou au moins comme l'homologue du calcanéum".

Now that the primates can be added to the list of species possessing a separate bony epiphysis, this view seems to be much strengthened.

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[1] Harris, H. A., *Nature*, **153**, 715 (1944).
[2] Quoted from Retterer, Ed., *C. R. Soc. Biol.*, x, 617 (1898).
[3] Albrecht, P., *Pres. Médic. belge*, **42**, 9 (1884).
[4] Baur, G., *Zool. Anz.*, **8**, 326 (1885).
[5] v. Bardeleben, K., *Proc. Zool. Soc.*, 354 (1894).
[6] Retterer, Ed., *C. R. Soc. Biol.*, x, 435 (1898).

I am most indebted to my two former colleagues for pointing out the previous descriptions of the epiphysis in the pisiform bone by Retterer and Sieglbauer. I had previously consulted several anatomists on this point, but without success. *Magna est veritas* . . .

The additional radiographic evidence by my former student Eckstein as to the time of appearance and union of this epiphysial ossification centre in the Rhesus monkey is of great interest. The pisiform, so often dismissed as a minisculum, may yet be of inordinate morphological significance. Haines and Hughes have looked in the library; Eckstein has looked in the monkey!

H. A. HARRIS.

# A CRYSTALLINE SERUM MUCO-PROTEIN WITH HIGH CHOLINE-ESTERASE ACTIVITY

By DR. R. BADER, DR. F. SCHÜTZ and DR. M. STACEY

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THROUGH the work of Dale and Loewi and their schools, acetylcholine is recognized as the effector substance of the cholinergic system and is known to be decomposed by an enzyme present in serum and tissues[1] which is designated 'choline-esterase'[2]. It appears to be an undecided question whether choline-esterases from different tissues, such as blood and brain, are identical.

Some recent work[3,4] made it desirable to have a highly purified preparation of choline-esterase available for experimental and perhaps clinical investigations. A method was therefore devised whereby good yields of very active and frequently crystalline preparations can consistently be obtained. In our hands, Stedman's method[5] gave somewhat irregular results and the products were invariably contaminated with serum albumin. One of the essential features of our method, briefly outlined below, involves adsorption on foam, a technique[6,7] which at certain stages gives a sharp separation of closely related substances. The main stages in the purification were as follow.

(*a*) Solid ammonium sulphate (250 gm./litre) was added to fresh horse serum, kindly provided by Dr. J. W. Trevan, director of the Wellcome Physiological Research Laboratories, and the relatively inert precipitate was rejected. A further 150 gm. of ammonium sulphate were added for each litre of the mother liquor and the precipitate was dissolved in water. From this solution the lipoids were extracted by precipitating the proteins at $-15°$ C. according to Hewitt's modification[8] of Hardy and Gardiner's method. The ether-washed precipitate was then extracted in a Soxhlet for at least forty-eight hours with ether containing metallic sodium, both of which were once renewed. The extracted material (a powder) was dried in a vacuum. It was then made into a paste with water and dialysed at 0° for several days against frequent changes of distilled water saturated with chloroform. A precipitate of inert insoluble material was then separated (centrifuge). The activity of the solution was twice that of the original serum.

(*b*) The solution was then frozen (twice) at $-72°$. From the thawed solution considerable amounts of inactive material were removed by adsorption with specially prepared fuller's earth at $+2°$ C. The adsorption, which required several days for completion, was controlled by frequently estimating the activity per dry weight of the solution. The fuller's earth was removed (centrifuge) and the yellow, slightly turbid solution had an activity per dry weight of about 4–6 times that of the original serum.

(*c*) The solution was adjusted to *p*H 8 (caustic soda) and foamed[6,7] at 0°. In this process a slow stream of nitrogen was bubbled through the liquid and the rising foam separated from the bulk of the solution. When foamed at an acid *p*H, much of the choline-esterase was adsorbed on the foam, but its purification was unsatisfactory. If foamed at an alkaline *p*H it remained almost entirely in the liquid while a considerable quantity of inactive material passed over in the foam. The foaming was continued until the residual liquid did not contain any heat-coagulable substance (100°) and until the foam time[9] was reduced to about a twentieth of that of the original solution. This required approximately three days, and usually up to 15 per cent of the original liquid was removed in the foam. The residual liquid now had an activity per dry weight 8–16 times that of the original serum. It had a *p*H of 8·5, while the liquid removed as foam had a *p*H of 5.

(*d*) To the clear colourless residual liquid solid ammonium sulphate (350 gm./litre) was added and the solution kept overnight at 0° (*p*H 6·0). The precipitate was rejected and a further amount of solid ammonium sulphate (100 gm./litre) added to give a precipitate, *A*. If instead of adding solid ammonium sulphate to the solution, the latter was dialysed against an aqueous ammonium sulphate solution (450 gm./litre), a frequently crystalline precipitate (Fig. 1) was obtained. These crystals, dissolved in water and dialysed against water, showed an activity (per dry weight) of approximately 20 times that of the original serum. They had essentially the properties of the preparations described below, but optimal conditions for their separation in quantity have not yet been worked out. The precipitate *A* was further purified by reprecipitation and thorough dialysis against water. When samples of this product were dissolved in water, adjusted to either *p*H 3 or *p*H 8 and evaporated cautiously at room temperature, a partially crystalline mass was formed. The crystals obtained at *p*H 8 always had the form shown in Fig. 2, and those at *p*H 3 were less well defined though both had an activity (per dry weight) of 20–25 times (and sometimes even higher) that of the original serum. No crystalline material could be obtained in the *p*H range of 3–8, and the best conditions for crystallization have not yet been worked out.

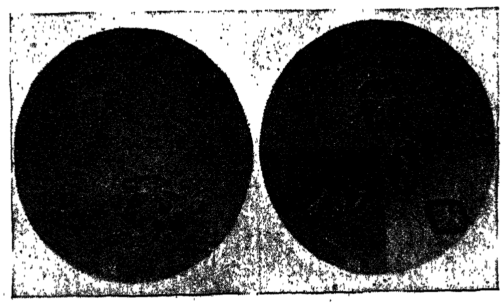

FIG. 1. FIG. 2.

Without previous foaming similar precipitations did not give preparations free from heat-coagulable substances or of such high activity. A typical preparation which in the dry state remained active over a long period was free from phosphorus and sulphur, showed $[\alpha]_D - 35°$ in water, nitrogen 12·4 per cent and had the properties of a mucoprotein[10]. Freshly prepared solutions contained no heat-coagulable substance (at *p*H 5), although precipitates were obtained with the following reagents: 50 per cent ammonium sulphate, 10 per cent trichloracetic acid, Esbach's picric acid, basic lead acetate, phosphotungstic acid. Sulphosalicylic acid and 1 per cent trichloracetic acid gave a turbidity only. The xanthoproteic (colour, but no precipitate), biuret, Millon, Sakaguchi,

glyoxylic and other tryptophane tests were positive. In freshly prepared samples the ninhydrin test was negative, but samples which had been kept in solution at room temperature for several days and which rapidly lost activity readily gave this test. Samples hydrolysed by either acid or alkali gave a vivid colour with ninhydrin (deep purple slowly fading to cherry red). The Molisch test for carbohydrate was strongly positive and was typical of that of 'bound' carbohydrate, in which the Molisch colour develops relatively slowly but remains stable for periods up to several hours. After hydrolysis, products were obtained which reduced Fehling's solution weakly and gave a positive Elson-Morgan test for amino-sugar. X-ray powder photographs, kindly taken by Drs. F. J. Llewellyn and A. D. Booth of our X-ray department, of all crystalline samples showed a number of diffuse rings in which there was no evidence of a highly ordered structure. The photographs were similar to those of crystalline pepsin taken at the same time and to those of some crystalline 'globular' proteins as described by Astbury[11].

The yield of choline-esterase calculated on the amounts estimated in the original serum gave surprisingly high figures, usually between 60 and 100 per cent but often much higher. We interpret this result as being due to the existence in serum of one or more powerful inhibitors which were removed during the purification process. The figures representing activities are usually taken as an indication of the degree of purification. We prefer, however, to postpone the interpretation of the significance of these figures until further information is available on the above-mentioned inhibitor, and on possible activators removed during the purification process.

We do not attempt at this stage to claim that the crystalline mucoprotein is indeed the pure enzyme, but the absence in the preparation of heat-coagulable albumins and globulins, the steady and regular increase in activity per dry weight during the process of purification and the initial negative ninhydrin test make it appear probable that the choline-esterase activity is intimately connected with the mucoprotein. It appears, moreover, to be the first mucoprotein which has been separated from the albumins and globulins of serum by a method which avoids the use of substances (such as alcohol) or procedures (for example, heat) known to denature or to destroy enzymes, in particular choline-esterase. Mucoproteins, having varying amounts of carbohydrate residue, have frequently been prepared from serum after removal of albumins and globulins by coagulation methods involving the use of heat and alcohol (for literature see Rimington[12]). Our preparation had some properties similar to those of seromucoid[12], but the method of preparing this mucoprotein would, of course, destroy choline-esterase activity.

Since this work was completed, there has appeared a paper[13] on "pseudo-choline-esterase" which the author has isolated in 5 per cent yield from horse serum and which is claimed to have an activity 5,000 times that of serum. The reason for the big discrepancy between this apparent high activity and our own is not immediately clear. In view of the fact that despite experimental losses our yields are so consistently high, we are inclined to the view that the divergence lies in the method[14] of assay of the enzymic activity; particularly since we have preferred not to use any enzyme stabilizer (gum acacia) and have worked with lower substrate concentrations.


[1] Loewi, O., and Navtril, E., *Pflug. Arch.*, **214**, 678, 689 (1926).
[2] Stedman, E., Stedman, E., and Easson, L. H., *Biochem. J.*, **26**, 2056 (1932).
[3] Schütz, F., *Nature*, **148**, 725 (1941).
[4] Schütz, F., *Quart. J. Exp. Physiol.*, in the Press.
[5] Stedman, E., and Stedman, E., *Biochem. J.*, **29**, 2563 (1935).
[6] Schütz, F., *Nature*, **139**, 629 (1937).
[7] Bader, R., and Schütz, F., *Trans. Faraday Soc.*, in the Press.
[8] Hewitt, L. F., *Biochem. J.*, **21**, 216 (1927).
[9] Schütz, F., *Trans. Faraday Soc.*, **38**, 85 and 94 (1942).
[10] Stacey, M., *Chem. and Ind.*, **62**, 110 (1943).
[11] Astbury, W. T., "Textile Fibres Under X-Rays", 46 (I.C.I., Ltd.).
[12] Rimington, C., *Biochem. J.*, **34**, 931 (1940).
[13] Strelitz, F., *Biochem. J.*, **38**, 86 (1944).
[14] Schütz, F., *J. Physiol.*, **102**, 259 and 269 (1943).


## UNIVERSITY DEVELOPMENTS IN GREAT BRITAIN

THE Conference on University Developments, arranged by the Association of University Teachers on June 2, at which representatives of twenty universities and colleges were present, considered three of the main topics of the Report on University Developments adopted by the Council of the Association in December and published in the *Universities' Review* of May. First, Prof. Ray Pascal opened a discussion on university entrance requirements, maintenance grants, curricula and appointments boards. Emphasizing that the consideration of such matters pertaining to the teaching functions of universities could not be conducted without reference to other functions such as research, Prof. Pascal directed attention to two main objects behind the proposals of the Report: the development of people who will make a useful contribution to society in whatever profession they may choose; and the development of individual personality of people able to "distinguish, choose and judge". Too often we have aimed alternately at one or the other. The Council of the Association does not believe that this is either good or necessary. We need not only really efficient experts but also efficiency in the widest sense applied to society as a whole, calling for broad knowledge and understanding, for initiative, adaptability and personality. The proposals to replace the scholarship system by one of maintenance grants, to change the character of the entrance requirements and to adapt the curriculum are all intimately related, and Prof. Pascal noted that related views have been expressed in the report of the Education Committee of the Federation of British Industries.

In regard to maintenance grants, the Association is concerned not only that the best should be provided for, but also that a great number of average good students should be forthcoming. Many scholarships awarded in recent times have denoted not special academic merit, but a recognition of fitness to study, and a change in name to correspond with this fact is proposed and an increase of 50 per cent in such grants—a provisional figure which can be soon attained without extensive new building and for which reserves of university teachers can be found. In regard to entrance requirements, the Association's proposals to correct the bias towards premature specialization centre in the transformation of the higher school certificate into a school-leaving examination in about six subjects, and useful for all leaving purposes, not merely for the universities. For university entrance, a further examination is needed

in a smaller number of subjects, but so framed as to prevent exclusive concern with two or three subjects over a long period. Here agreement and co-operation between universities rather than uniformity is required.

The Association's criticism of degree courses is that too many students specialize who are not fitted for the most advanced specialist work, and that the best students need a broader basis. It proposes a common course in the first year or two, followed by full specialization for those suited by ability and bent, and extension of the normal university course to four years once the post-war rush is over, with a much larger entry for the general degree course. Again, in regard to appointment boards, these should be bodies on which university teachers meet employing bodies to exchange information and to consult together on the relations between education and employment.

Dr. D. R. Pye, opening a discussion on research, using the word in its widest sense as giving vitality to teaching, pointed out that while it cannot be expected that all members of a university staff will remain productive in research, much good would result from closer association between universities and the research staffs both in Government establishments and in industry, and he referred to the value of university lectures by research workers on their special subjects as a stimulus to post-graduate research groups in the universities. Also it must be possible for the universities to pay salaries which are adequate to retain the men who are capable of effective research and of training recruits in research; the number of such men must be sufficient to prevent them from being overburdened with teaching.

The closer association of the universities with industry presents special difficulties in the engineering faculties. Here, except in the borderland of physics and engineering, and especially towards the physical side, effective research is difficult to arrange at the universities, and it will always be difficult for the university work to keep in touch with changing technique. Accordingly, Dr. Pye welcomed the encouragement of local contacts with industry. He deprecated too close inquiry as to whether research is pure or applied: freedom in planning and in execution are pre-requisites for research which is worth while, but a fairly definite goal is no bad thing for the majority.

Prof. S. Brodetsky, opening the third discussion, on salaries, superannuation and representation of academic staff and academic council of the universities, said that a considerable increase in the staffs of universities is clearly necessary as well as a new scale of salaries, but he appeared to be opposed to the establishment of further research fellowships as recommended in the Association's Report. In regard to the new scale of salaries suggested, he emphasized the desirability of discontinuing the so-called "Grade IV" appointments, and, secondly, that lecturers should reach a reasonable salary by about the age of forty. The Report proposes a salary of £800 to be reached by annual increments, following a probationary period, at about that age. Higher appointments, such as Grade I lecturers or readers, should similarly rise to £1,100, non-professorial heads of departments to £1,300, and for professors a basic salary of £1,500 is suggested. With regard to superannuation, a special Government grant is called for to put on a reasonable level members of university staffs of long service.

Prof. Brodetsky also directed attention to the importance of university teachers taking a proper place in the administration of the universities, and to the recommendations in the Association's Report that university councils should include a fair representation of the university staff, both professorial and non-professorial. Each university should have permanent academic committees dealing with the question of development and other problems, while in connexion with regional universities special thought must be given to the place that graduates should occupy in their development and government. Finally, referring to the relations between the universities, he explained the reasons why the Association's Report recommended the establishment of an academic council of the universities to facilitate consultation and the work both of the University Grants Committee and the informal Vice-Chancellors' Committee.

The summer meeting of the Central Council of the Association of University Teachers took place on June 9 and 10 at the University of Birmingham. Forty-five members were present, representing the local associations in the various university institutions of England and Wales. The action of the University of Birmingham in making a gift of £100 to the University Books for China Fund, following an appeal made by Prof. E. R. Dodds, of the University of Oxford, who had recently returned from a visit to Chinese universities, was brought to the notice of members in the hope that other university institutions might feel able to help in a similar manner. A report was made regarding the conference of representatives of university governing bodies and members of the executive committee of the Association which took place on June 2 (see above). A Conference Committee was appointed to arrange for a series of conferences with, among others, school teachers and professional, technical and industrial organizations, the National Union of Students, etc., to consider specific problems arising out of the report. Copies of a booklet on "Health and the Student", issued by the National Union of Students, were before the meeting and, after consideration, it was agreed that it was desirable to support the efforts of the Union in this direction, and to recommend local branches to raise the whole question of student health (including medical care and welfare, living conditions and recreative facilities) with their governing bodies. The election of officers for the session 1944–45 was proceeded with, Prof. Roy Pascal of the University of Birmingham being appointed president.

## A FLATWORM PARASITE OF FRESHWATER TROUT

INVESTIGATING the cause of the deaths of practically 100 per cent of the freshwater trout in an open storage reservoir in South Wales in 1942, J. B. Duguid and Edith M. Sheppard (*J. Path. and Bact.*, **56**, 73; 1944) found that they were due to general peritonitis caused by the plerocercoids of a tapeworm belonging to the family Diphyllobothridæ. Hundreds of these flatworms, 1–10 cm. long, were found burrowing in the peritoneal tissues. The sticklebacks (*Gasterosteus aculeatus*) in the same reservoir were also infested.

The reservoir supplies domestic water and stands next to a suburban area, and is fed with filtered and chlorinated water conveyed by a closed pipe from reservoirs 25 miles away. A second smaller reservoir, separated only by a narrow embankment from the one in which the fish died, is used for industrial purposes and is fed from local streams. Both are stocked with trout and have been open to anglers for years. Apparently there have been no earlier outbreaks of disease in this reservoir. Many trout from other sources, including the supply reservoir 25 miles distant, were examined, but the cestode was not found in them, until, in March 1943, it was found in trout from the second smaller reservoir.

When the plerocercoids were fed to laboratory rats and to one dog, they developed into adult worms which resembled *Diphyllobothrium latum*, the 'broad tapeworm' of man. On the other hand, when they were implanted into the subcutaneous tissues and peritoneal cavities of rats, they did not multiply, but were encapsuled by fibrous tissue, remaining alive for three weeks. Identification of the species of the family Diphyllobothridæ is difficult, because only one stage in the life-histories of so many of them is known. The identity of the species found in these trout with *D. latum* of man has not yet been fully established. The adult, the egg, the coracidium and procercoid seem to correspond with those of *D. latum*, but the plerocercoids do not; they seem to correspond with the descriptions given of *Dibothrium cordiceps*, which caused epidemics in trout in one of the Yellowstone Park Lakes. Similar epidemics have occurred in Elk Lake, Oregon and in California. Some helminthologists regard *D. cordiceps* as being identical with *D. latum*; others do not.

The authors' further work on the identity of this parasite will be awaited with interest, because *D. latum* is recorded in the British Isles only from the west of Ireland. To this record, Duguid and Sheppard add the Shetland Islands, where it is, they conclude from material supplied to them by Dr. Peterson of Yell, endemic among the freshwater trout of certain areas. *D. latum* is described as being cosmopolitan by some authorities, but the most important foci of it are all around the Baltic Sea, some of the Lakes of Switzerland and Italy, Bavaria, Hungary, the Danube delta, Poland and Rumania; it is also common in Turkestan and parts of Siberia and Japan, and foci are known in Africa. Its definitive hosts, apart from man, include the dog, cat, pig and various aquatic and terrestrial carnivores. It requires two intermediate hosts, a freshwater copepod and a freshwater fish (perch, pike, salmon trout, etc.). The Cyclopidæ *Diaptomus gracilis* and *Cyclops strenuus* are commonly the crustacean hosts, and Duguid and Sheppard describe the life history of the South Wales species in these two copepods. They had not, at the time of writing, infested fish by feeding them with infested copepods. Nor could they explain how the parasite got into this carefully protected reservoir. They found little evidence that birds (for example, the gull) brought it there; it seemed more likely that a small mammal was the carrier. One Belgian soldier, who was later found to be a carrier of *D. latum*, had camped in the neighbourhood.

Commenting on this paper, *The Lancet* (April 8, p. 475) points out that *D. latum* has been introduced by immigrants into the United States, and suggests the possibility that it may have been brought to Great Britain by refugees from Norway or Poland.

G. LAPAGE.



# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

British Rubber Producers' Research Association. Publication No. 46: Strains in an Inflated Rubber Sheet, and the Mechanism of Bursting. By Dr. L. R. G. Treloar. Pp. 12. Publication No. 47: The Structure and Elasticity of Rubber. By Dr. L. R. G. Treloar. Pp. 24. Publication No. 48: Rubber, Polyisoprenes and Allied Compounds, Part 6: The Mechanism of Halogen-substitution Reactions, and the Additive Halogenation of Rubber and of Dihydromyrcene. By George F. Bloomfield. Pp. 8. (London: British Rubber Producers' Research Association.) [147

Royal Society for the Protection of Birds. Fifty-third Annual Report, January 1st to December 31st, 1943, with Proceedings of Annual Meeting, 1944. Pp. 48. (London: Royal Society for the Protection of Birds.) 1s. [147

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CONTENTS



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# RECONSTRUCTION IN THE CIVIL SERVICE

In the debate which took place in the House of Commons on January 28, 1943, on the sixteenth report for the session 1941–42 of the Select Committee on National Expenditure, on "Organization and Control of the Civil Service", the Chancellor of the Exchequer, Sir Kingsley Wood, welcoming the general tenor of the Committee's observations on the establishment of a Civil Service staff college, stated that he proposed to start at once an investigation into the general question of the training of Civil servants, including that of the establishment of a staff college, its form and character. A committee was appointed for this purpose in February 1943 under the chairmanship of the Financial Secretary to the Treasury, the Right Hon. Ralph Assheton, and its report was duly presented to Parliament in May last.

In the meantime, the importance of the question of training of Civil servants has steadily become more widely recognized. In the attention which has been given to the machinery of government by such bodies as Political and Economic Planning, the importance of men as well as the right methods has been repeatedly emphasized. The same question has been to the fore in current discussions on the reform of the Foreign Service and on proposals for a civil or economic general staff. Already education for the public services has been considered in a special report of the British Association Committee on Post-War University Education, while further discussion of the question has been stimulated not only by the White Paper on Education but also by subsequent papers on health services and employment. The proposals in the latter paper for a strong central economic staff were rightly stressed by the present Chancellor of the Exchequer and were warmly welcomed by many members of Parliament in the debate.

It has, in fact, become increasingly clear that in the successful execution of whatever plans we may make for our post-war reconstruction, much will depend on the calibre of the men to whom their execution must perforce be entrusted. It is, of course, above all in the technical field that complexities multiply; and the larger the part that science has to play in the ordering of our affairs, the greater the need for decisions and policy to be based impartially on scientifically ascertained facts. If the State is to discharge effectively its more active duties of planning and supervision, the more imperative is the need for the Civil Service to be trained for the job it has to do. The Assheton Report does not, it is true, pursue in detail the training of the professional and technical grades. That is not the special issue at present, except in so far as it is bound up with the general question of technical education in relation to industrial efficiency under the plans for educational reconstruction. What is at issue is that members of these classes should, as was most emphatically stated in more than one recent debate in Parliament, have fuller opportunities of transfer to the administrative class, when they show themselves to possess administrative ability. There must be much

more adequate encouragement of a process of such direct value to the machinery of government, apart altogether from its indirect effect, through the higher status and wider prospects given to the scientific worker, in attracting to the service of the State a freer supply of men of outstanding scientific as well as administrative ability.

For this reason, as a preparatory step, recruits to the professional and technical classes might, as the Report suggests, usefully share in the reception arrangements and background training which are recommended for all Civil servants, so that they may be seized of the functions of the government machine generally and the procedure of their own departments in particular. Again, members of these grades, who are in certain respects analogous with the administrative class and with the higher levels of the executive class, should also be given, where appropriate, the same opportunities for acquiring wider experience by the study of outside methods and by other measures such as are recommended by the Report. Training, it is observed, cannot be considered in isolation; such matters as recruitment, allocation, probation, transfer and promotion are all involved. All indeed are considered by the Report in so far as they are factors in determining the character and extent of training, and the efficient performance of those functions which must fall to the lot of a Civil servant more and more concerned with the affairs of the community and acting as the servant of the State in numerous ways which involve contact between the government and the individual citizen.

The Report itself is in two parts. The first deals with general considerations and principles; the second indicates some of the ways in which they can be applied to the various grades that have come under review. Looking first at general principles, the Report recommends that the Treasury should exercise general control over training and should appoint a director of training and education. Within each department there should be a planned training scheme under the general control of the head of the department, with at least a part-time departmental training officer. The National Whitley Council should be associated with general training policy, and departments should invite the co-operation of staff representatives in working out departmental schemes. Not only should great care be taken in the selection of teachers, but also attention should be paid to the surroundings in which people work.

The reasons for these recommendations are cogently set forth in the Report. There can be no dissent from the Committee's view that training schemes will not prosper unless responsibility for their success is firmly placed on some individual. The Treasury's responsibilities for establishment work and the new development of the Organization and Methods Division make it logical that general responsibility for training should also be with the Treasury. Again, the element of staff co-operation is emphasized in a way which represents a break with tradition and a look forward to that closer integration of the service with the community, which is just as important as that of industry with the community, in order that the needs of to-morrow may be served. The emphasis on personality in teaching and on environment equally betoken a forward-looking mind. Indeed, it cannot be too clearly emphasized that the Report is largely breaking new ground and that its recommendations are experimental; that, far more than shortcomings or defects of the past laid bare in the Report, is what matters, and what should ensure it a sympathetic reception and patient and full discussion.

The objects of the training to be given could, in fact, scarcely be better put than in this Report. Public confidence is essential if the Civil Service, however admirably trained for its more positive functions, is to discharge its new duties effectively. We may take for granted that training should endeavour to produce a Civil servant whose precision and clarity in the transaction of business are accepted. Equally we have no right to expect that the Civil servant will be attuned to the tasks he is called upon to perform in a changing world, or that he will be able continuously and boldly to adjust his outlook and methods to meet the new needs, unless we are prepared to support him with sympathy and understanding, and temper criticism with discernment.

It might well be observed in passing that the stress laid in this Report on the human aspect among the objects of training should do much to promote such understanding of 'the man at the other end', and a real integration of the Civil Service with the community it seeks to serve. Measures which prevent the Civil servant from becoming mechanized by making him aware of the wider setting of his work, by training him, not solely for the job which lies immediately to hand, but also to fit him for other duties and to develop, where appropriate, his capacity for higher work and greater responsibilities, all assist to that end, as does the attention to staff morale which is emphasized. In such matters as these, in its frank recognition of the human problem presented by routine work and mechanization, the Report is pointing to problems which industry, too, must face in increasing measure. They are indeed already being faced by many progressive firms, as well as by the joint production councils, but they must receive far greater and wider attention.

Returning to the general principles recommended in the Report, there is emphasis on a real period of probation which would facilitate the early elimination of misfits. Next, there should be a routine of training for all entrants under a responsible officer. Mobility in the early years of service, both from branch to branch and from headquarters to out-stations, and easier transfer from one department to another are also recommended. Clearly much will depend on the careful selection of supervisors and their training in the principles of supervision, as well as on the ability of establishment officers, who should study staff management and office organization.

Despite many unexceptionable recommendations, much of the interest of scientific workers in this general part of the Report centres in the considerations which lead the Committee to reject the proposal that the Government should associate itself with the establishment of a national administrative staff

college, though if such a college is set up some Civil servants might attend experimentally. In the first place, the Committee concludes that little or no centralized or institutional training is needed for the clerical, executive and professional grades: the necessary training is most readily and effectively given by departments. For the administrative officer, however, the Committee sees a real need for a central organization to give the appropriate teaching about the background and methods of Civil Service administration to recruits to this grade of all departments. Further, such an organization should serve a useful purpose in bringing together administrators at a later stage for discussion and investigation of common problems.

The Committee thus visualizes training primarily for new entrants and not, as in the staff colleges of the Armed Forces, for those selected as suitable for promotion after some years of experience. Again, while heartily in favour of encouraging contact between Civil servants and workers in other departments of life, especially in commerce and industry, the Committee does not think that these contacts can best be secured through a common course of instruction in administration. Both the lessons and the illustrative matter of Civil Service administration are regarded as too specialized to be made useful in a college of the kind suggested to the Committee. Further, from the evidence, the Committee thinks that there is a danger that such an institution would end by becoming a commercial college concerned with office methods, and that a real opportunity of assisting the Civil Service administrator to a rapid comprehension of the nature of his problems and of the lines of thought and action he should follow would be lost if such training were merged in a generalized administrative course for both business and the Services.

The Committee's own proposals are elaborated more fully in Part 2 of the Report, in considering the post-entry training of the administrative class. Here more than anywhere, the Report breaks new ground, and it is satisfactory to note that there is no suggestion that Civil servants should not receive their training in the universities or other institutions of similar rank in company with men and women destined for other careers. We can find nothing in the Report to warrant the anxiety expressed last year in these columns (*Nature*, **151**, 512; 1943) that entry will be unduly restricted or the functions of the universities be adversely affected. It may, indeed, be argued that something more of the principles of administration might well be taught prior to entry to the service than the Committee is inclined to admit; but incontestably there is much training in internal methods and background that has hitherto not been given at all, or at best unsystematically, and which can only be given effectively after entry to the service.

The section of the Report in which the Committee's own ideas are outlined deserves careful attention, for if some of the proposals are admittedly experimental, the Report reveals an urgent need for action. Moreover, if as it appears the Committee has taken rather too narrow a view of its scope and under-estimated the potentialities of the staff college idea, it is to public discussion that we must look for the corrective in the first instance.

As regards the administrative cadet, the Committee suggests a course of two to three months requiring an average attendance of about two days a week, the object of the course being to shorten the process by which the recruit forms his own administrative standards, and to inculcate from the beginning of his service a professional approach. As set forth in the Report, much of the syllabus appears to be of wider validity than the Committee is disposed to admit. The reference to training in methods of preparing and presenting statistics, and the logical principles underlying their interpretation, is welcome, and the Committee is on firm ground in urging that the close relation of such a course to a Civil servant's particular job might well increase its vitality and value. Moreover, from the comparatively modest beginnings outlined, the Committee visualizes the development of a centre which could serve as a clearing-house of ideas for Civil Service administrators and a repository of schemes, successful and unsuccessful, which have been tried out in practice. In fact, after rejecting the idea of a staff college, the Committee sees such a centre organizing refresher courses in which something resembling the methods of the military staff college could be attempted, officers of various departments meeting in study groups to work out hypothetical or actual administrative problems. Participation of representatives of commerce and industry and other organizations in such discussions is suggested, and the sharing of experience between business men and Civil servants is recognized as mutually valuable.

In recommending the fullest use of the centre for all these purposes, the Committee does not appear to be entirely consistent, despite its belief in the value of contacts between Civil servants and commerce and industry. Moreover, it must be admitted that the Committee does not seem to be sufficiently alive to the dangers of departmentalism, and however unexceptionable may be its further suggestions for training the recruit by discussions, visits, field-work and the like, some legitimate doubt may well be entertained of their effectiveness in dealing with an evil which is not confined to the Civil Service. Something of the same timidity characterizes the discussion of the training of those intended for positions of high administrative responsibility also.

Here the Committee accepts the general view that in the early thirties a complete change of environment or an opportunity to stand back from one's job and to shake oneself free from the daily routine is most desirable to gain a broader vision and some fresh experience. Without questioning the value of transfer within the Service from one department to another, or from headquarters to out-station, or vice versa, for refresher purposes or for widening experience, it rightly insists on the need for opportunity to get away for a time into a different atmosphere altogether, by a period of secondment elsewhere, for example, to outside business or a local authority. The former is regarded as of little value unless for a period of anything up to two years, so that the Civil servant could do a real job of work and be entrusted with real

responsibility. This method is therefore considered one for tentative experiment rather than definite recommendation. Seconding to, or interchange on a two-way basis with, a local authority is, however, a more promising and less difficult way in which the Civil servant should have opportunities for appreciating more readily the impact of action at the centre upon local government and upon the general public. The Committee recommends accordingly that departments such as the Ministry of Health and Board of Education should consider and report on such possibilities. Beyond this, the Committee suggests that selected Civil servants, say in the early thirties, should be granted a period of sabbatical leave to pursue an approved course or to undertake research, either in Great Britain or abroad. Such leave should be with pay and should count as service for purposes of pension.

The Committee is clearly in sympathy with the proposal of the recent British Association Committee on Post-War Education, but contemplates something beyond the social studies suggested by that report. Again, it takes up a suggestion emphasized in a Planning broadsheet, "A Civil General Staff", in commenting on the ignorance of Civil servants of the relevant experience of other countries, and strongly commends the idea of giving selected officials an opportunity of travelling abroad to study aspects of government or public administration likely to be of value. Study of the way in which problems of government are tackled abroad would be worth while in itself as a safeguard against insularity, as well as providing a stimulant which would be of great benefit to the Service.

The Committee does not overlook the current criticism that the Civil Service is not sufficiently alive to the possible effect of its actions upon business undertakings; and that its members, in those departments which come into daily contact with commerce and industry, should be equipped with a fuller understanding of their problems. This contact, it suggests, should be secured by visits and periods of observation, varying in duration from a week to a maximum of two or three months. By such arrangements it is believed that selected Civil servants might acquire a better insight into the methods and problems of the industrial and commercial world, while at the same time business men might gain a better understanding of the point of view of the Civil servant.

There can be no doubt that a number of these suggestions need to be explored seriously and thoroughly and with some urgency, whether or not the Committee is unduly optimistic as to the effect, particularly of this last suggestion. On the other hand, the Committee is assuredly correct in pointing out that the need for Civil servants to acquire the right attitude of consideration and sympathy towards the public should not lead us to forget that this attitude should be mutual. A spirit of service cannot be expected to flourish among public servants if they feel with reason that their efforts are being disparaged and their difficulties overlooked by those whom they are endeavouring to serve. A more generous appreciation by the public of the work of the Civil Service would go far to ensure that such appreciation was increasingly deserved. It is somewhat surprising that the Report appears to overlook the influence which the considerable number of temporary Civil servants recruited for war purposes—estimated in a debate last year at some 300,000—might well exert in this respect; but the point is one which should not escape the public relations officers of the Service.

The Report must now be subjected to constructive and informed criticism, to ensure that full advantage is taken of any fresh experience acquired as a result of the experiments which the Committee suggests. Judgment may well be reserved on a number of points: some of the present defects may be more deeply embedded in the administrative system than the Report admits. Here, however, is positive and constructive criticism comparable with that which characterized the report of the Select Committee on National Expenditure. Defects are laid bare and weaknesses admitted, and it is unthinkable that the situation will remain as it is. Neither the Government nor the Civil Service can allow the charge of neglect of systematic post-entry staff training in peace-time to be levelled again. Whether or not the measures at present advocated are entirely adequate to attain the objectives so admirably stated, they should at least promote the ever-present consciousness of the importance of clarity of thought, directness of action, simplicity of expression, speed, initiative, considerateness and other virtues, in which Civil servants are often said to be deficient—and which are not always conspicuous in their detractors. The Report clearly believes that training and good staff management will do much to make these the keynotes of daily practice in all ranks from the highest downwards, and the confidence it shows thereby in the essential qualities of the present Civil Service in Great Britain is in keeping with the whole spirit of the searching debate in the House of Commons which initiated the inquiry.

# FARMING IN WORCESTERSHIRE, PAST AND PRESENT

**A History of Worcestershire Agriculture and Rural Evolution**

By R. C. Gaut. Pp. xvi+490. (Worcester: Littlebury and Co., Ltd., 1939.) n.p.

WORCESTERSHIRE is one of the smaller counties of England and is neither a tourist nor a holiday resort; but connoisseurs know it as one of our most interesting regions. Through it pass three peaceful and attractive rivers, the Severn, the Avon and the Teme; its scenery is varied by Bredon Hill, the Malverns, the Clent and Lickey Hills and by the Forest of Wyre. Some of the most intensive culture in England is to be found in the Vale of Evesham. The county is rich in archæological interest, for the monastic movement played an important part there, and parts of the great Abbeys of Evesham and Pershore still survive in a setting enriched by interesting churches, attractive country houses and quiet, pleasing villages.

Mr. Gaut has had a long and honourable connexion with the county as its chief agricultural adviser, and

he has had the energy and enterprise to record his unique knowledge of its agriculture past and present.

Records of varying degrees of completeness go back to very early times, and Mr. Gaut begins with the Celtic settlements, of which, however, very little can be said. His method here is to fit the local information into a more general framework, thus giving the book a wider interest than would be attached to a purely local history. From Norman times onwards much more material is available; Domesday Book, the Inquisitions, church records and other sources are all utilized. In the thirteenth and fourteenth centuries sheep seem to have been the mainstay of the agriculture: a wether in good condition weighed about 40 lb. and yielded about 1–1½ lb. of wool, worth about 3*d*. per lb. Several diseases were troublesome; 'rot' was prevalent in wet seasons and there was much scab, for which iron sulphate, verdigris and mercurial ointments were used until the fourteenth century, when tar became the universal medicament for skin diseases. Sheep seem to have been worth about the same as wild rabbits. The carcase weight of the cattle was about 400 lb.; oxen were worth about 11*s*. each. Early horticultural records are scanty; but the county appears always to have produced good vegetables and fruit, including vines. Specialization had not yet begun, however, and Leland, who visited the Vale of Evesham in the years about 1540, was impressed not by its fruit and vegetables but by the quality of the corn grown there. Even then, however, the orchards of the county were notable, for they are praised in a Latin distich of Henry VII's time (1485–1509), which we should like to have seen quoted.

From the seventeenth century onwards the references to fruit and vegetables become more numerous: they may have gained in importance as the forests were cleared to provide wood for the making of charcoal for the smelting of iron. There are early eighteenth-century complaints that hops and potatoes were "destructive to land because they breed no manure: they take from it, but give nothing back to earth". Leases imposed a penalty of £5 per acre for breaking up grassland to grow hops or corn without permission. There is a curiously modern ring about the further complaint that hops are bad for the farm because they receive all the manure, nothing being left for other crops.

By the second half of the eighteenth century the special character of Worcestershire agriculture was already established. In 1782 the Vale of Evesham was described as "the Eden of England in respect to gardening". In some years, the account continues, one hundred thousand bushels of cucumbers were sent to the different neighbouring counties; asparagus went to Bath and Bristol; early potatoes, kidney beans, lettuce, broccoli, cauliflower, endive and other vegetables were produced in quantity.

Marked progress in horticulture set in after the formation of the Royal Horticultural Society in 1804; this stimulated the formation of local societies, which by their shows and premiums greatly encouraged the introduction of better methods and the selection of improved varieties of crops. Accounts are given of the activities of some of these early societies and of the gardeners and nurserymen of the county to whom so much of its subsequent progress is due.

But all Worcestershire is not market gardening, and the heavy-land farmers passed through a very difficult period in the latter part of the nineteenth century: by 1877 thousands of acres were tenantless. Wheat had been the chief crop, and to maintain soil fertility the farms had been well stocked with sheep and cattle. The ancient practice of burning the stubble still survived and was considered highly beneficial. Fortunately not all farmers suffered so badly: Benjamin Bomford, described by Mr. Gaut as the greatest arable farmer Worcestershire has ever produced, learned to use big farm machinery and added farm to farm until at his death in 1880 he was farming some six thousand acres. It is said that on one occasion he brought together and set to work for his guests £9,000 worth of steam tackle which in a few hours ploughed an area equal to that of a good-sized farm. Happily, his descendants have continued to develop farm mechanization and to maintain the family tradition of efficiency and hospitality: it is not long since the writer attended with special pleasure a demonstration of modern implements and methods on one of their farms.

The Worcestershire County Council was set up in 1888 and soon began to arrange for agricultural education. In 1891 it made grants for the establishment of a County Dairy School and for the work of the Chamber of Agriculture and the Union of Workmen's Clubs; but the procedure was soon changed and the County Council itself undertook to provide instruction.

The County narrowly missed having one of the early schools of agriculture for farmers' sons. In 1898, Mr. John Corbett of Impney Hall offered to devote £50,000 for foundation and maintenance; but various legal difficulties arose and a special Act of Parliament was being drafted when the outbreak of the South African War put an end to the negotiations. Meanwhile, other provision was being arranged by the Board of Education. Later on, in 1925, the Avoncroft Residential College for Rural Workers was opened at Offenham and ten years later transferred to Stoke Heath. An experimental garden was established at Droitwich, but will now be transferred to Norton Hall, Worcester.

As in other counties, the population of the purely agricultural parishes has declined: in the cases quoted the fall from the peak in 1871 to what one hopes will prove to have been the minimum in 1931 was about 30 per cent; on the other hand the populations of the market-gardening parishes have gone up: some have more than doubled.

The book is full of interest and can be strongly recommended to all who are concerned with country life, agriculture or horticulture. In a future edition it would be well to insert some maps: these would heighten the value of the book and would considerably elucidate the text.

In other counties also there are men who have long served their farmers and growers and who have very full knowledge of the county agriculture. It is greatly to be hoped that they will follow Mr. Gaut's excellent example and record the information while the men who passed through the revolutionary changes of the past forty years still survive to give those details without which agricultural statistics are very lifeless. The success of the reconstruction after the War will depend on the amount of sound knowledge that can be put into it, and if each county could have as full and illuminating a record as this which Mr. Gaut has prepared, we could indeed feel that the basal facts were available to all charged with the duty of carrying out what is bound to be a difficult task.

E. J. RUSSELL.

# LIMITS OF EXTRA-SENSORY PERCEPTION

## Paranormal Cognition

Its Place in Human Psychology. By Dr. Laurence J. Bendit. Pp. 79. (London: Faber and Faber, Ltd., 1944.) 5s. net.

THIS short essay contains the substance of a thesis recently submitted to the Department of Medicine of the University of Cambridge, and approved for the degree of doctor of medicine. Although it contains little from the medical point of view and would seem more suitable as a thesis submitted to some psychological faculty, the book is of interest as it directs attention to a question which is bound to excite greater attention as time goes on.

For the purpose of his work, Dr. Bendit takes it for granted that what he calls "psychic" modes of perception exist apart altogether from the ordinary channels of sense. Indeed, he maintains that "science to-day accepts as fact that man has channels for obtaining knowledge of the world about him which are not those of the ordinary senses". Although he does not say what he means by "science" in this connexion, it is clear that the statement does not apply to scientific men taken as a body, although the opinions of the chemist on questions of parapsychology are no more valuable than those of the parapsychologist on chemistry unless both parties have studied each other's interests.

In the present volume Dr. Bendit assumes that what he calls paranormal cognition is a fact, and under this name he includes a number of forms of perception which do not fall within the range of abnormal hyperacuity of the senses but beyond them into a region where normal perception, however acute, no longer operates. Thus the 'paranormal cognition' of Dr. Bendit includes what the American school calls 'extra-sensory perception', although he seems to extend the scope somewhat to include other phenomena the precise nature of which is still a subject of controversy.

In the course of his discussion the author mentions the possible emergence of such material in the statements and dreams of patients undergoing psychological treatment; and he appears to think that the reports of psycho-analysts who state that they have found such instances among their patients constitute "an important class of literature" in this connexion. This brings us to the most important part of Dr. Bendit's thesis, in which the author seems to have fallen (or appears about to fall) into what might be grave sources of error of a type which have vitiated so much serious work in the past. Having become convinced that paranormal cognition is a fact, he goes on to assume that it can be suspected in cases contributed by persons, some of whom he names, whose work can only be regarded with much scepticism as to its reliability. Indeed, Dr. Bendit is so anxious to suggest that such cognition is widely distributed that he uses the work of E. N. Marais on termites as an example, although few entomologists would regard the theory of this author as proved, and indeed it has been characterized by one critic as "a poetical invention which gets us nowhere". It is the growth of this tendency to see something 'psychic' in phenomena hitherto not fully described or adequately studied that so many psychical researchers feared might be the result of an acceptance of some form of paranormal cognition on the basis of properly controlled and statistically analysed experimental data. One of Dr. Bendit's own collaborators in his thesis, to whose "specialized knowledge and experience of psychic matters" he owes a good deal, has published some of the results of using her alleged power of paranormal cognition, and it appears that she accepts many of the so-called physical phenomena of mediumship, including such almost wholly discredited manifestations as apports and slate-writing, and even claiming through her paranormal 'vision' to see the so-called ectoplastic rods used in levitating tables! How far Dr. Bendit is right in believing that these remarkable results are justified is for himself to judge. Others may be tempted to accept paranormal cognition just as far as the results of scientific experiment may compel them to do so, leaving the vast inchoate mass of borderland psychological phenomena to be included or rejected as our knowledge increases and as the range of our experiments becomes extended.

E. J. DINGWALL.

# A RUSSIAN TRIBUTE TO NEWTON

## Isaac Newton, 1643–1943

(In Russian.) Pp. 82+4 plates. (Kazan: Kazan Aviation Institute, 1943.) 10 roubles.

THIS booklet contains four addresses read at the celebration of Newton's tercentenary on April 9, 1943, in the Institute of Aviation in Kazan. The plain fact of such a celebration when a vital part of the U.S.S.R. was still under the German yoke is noteworthy, especially when it is realized that the man thus honoured was, after all, for Russians, a foreigner. In the general introduction and also in two of the addresses the same comment recurs—the U.S.S.R. celebrates Newton's memory amidst all her war-time occupations and worries, since she is fighting for "freedom of scientific, artistic, and philosophical creation".

In the first address, Prof. M. M. Kusakov reviews Newton's life and work, including his theological publications. Kusakov considers Newton to be the founder of the prevalent philosophy of the men of science of eighteenth and nineteenth centuries, which "represents a combination of primitive mechanical materialism with deism".

The fourth paper, by L. F. Rakusheva, deals specially with Newton's philosophy. Apparently, Newton did not bother to formulate his philosophy, if he had any; and the clarity and precision of his physical and mathematical passages contrast with his timid and contradictory pronouncements on philosophical problems. But Newton's scientific discoveries had a decisive effect on later philosophers. Quotations from Marx, Engels and Lenin show the relation between Newton's point of view and that of the dialectical materialism.

P. M. Dulski spoke on Newton's iconography. Unfortunately, the material expected from the Royal Society did not arrive, and the lecturer had to use only well-known published sources.

B. Stolbov gives an interesting account of Newton's optical work. He states that, contrary to the usual belief, Newton was just as much inclined to the wave theory as to the corpuscular theory of light.

J. J. BIKERMAN.

## Illustrated Technical Dictionary

Containing Standard Technical Definitions of Current Terms in the Applied Sciences, Graphic and Industrial Arts, and Mechanical Trades; including Air Navigation, Meteorology, Shipbuilding, Synthetics and Plastics; with Illustrations, Technical Data and Interconversion Tables. Edited by Maxim Newmark. Pp. xii+352. (New York: Philosophical Library, Inc., 1944.) 5 dollars.

TECHNICAL dictionaries are multiplying rapidly to meet the growing needs of a progressive civilization, and the Philosophical Library, New York, is placing itself in the vanguard of publishers who respond to this demand. Its new illustrated technical dictionary will be welcomed by scientific and technical workers of almost every kind; the book should find a home in most general libraries. The explanatory sub-title gives a good idea of its scope, with the emphasis on the mechanical arts, and the illustrations, which have been supplied mainly by engineering firms of standing, will be found very useful. The multiplicity of subjects and the necessarily limited space will doubtless invite some adverse criticism concerning lack of balance; but what may be important to the engineer or 'wireless' expert may be of little interest to the chemist, and vice versa. A primary consideration is that first things should be placed first, and in this respect there is little to cavil at in the present work; only a few slips and omissions have been noticed. The definition given of permeability refers only to gaseous diffusion: electric and magnetic permeability are not mentioned. The Baumé hydrometer is defined as a *scale* for measuring the density of a liquid. The chief use of ammonium sulphate, namely, as a fertilizer, is not given, nor is the use of urea in the manufacture of plastics. The uses of so many chemical products for so many purposes suggest that there is scope for a separate publication on this subject. It would be compendious and need constant revision, but it would be a boon to many manufacturers and industrialists; and it would form a useful companion volume to the present work of reference. E. H. T.

## Joint Progress Report on Reservoir Efficiency and Well Spacing

By the Committees on Reservoir Development and Operation of the Standard Oil Company (New Jersey) Affiliated Companies and of the Humble Oil and Refining Company. Pp. xix+77. (New York: Standard Oil Development Co.; London: Anglo-American Oil Co., Ltd., 1944.)

THIS report embodies the findings of two committees appointed respectively by the Standard Oil Co. (New Jersey) Affiliated Companies and the Humble Oil and Refining Co. to collate and interpret data on the effects of field operating practices and well spacing on the efficiency of oil recovery from natural underground resources. Each of the committees carried out pool studies of actual fields to obtain information on reservoir behaviour and oil recovery under various well-spacing and operating practices, in addition to a review of all available theory and research data.

It is concluded that the degree to which basic oil recovery mechanisms (dissolved gas drive, gas cap drive and water drive) will operate in practice, and possible oil yields obtainable, together with optimum economic well-spacing for a particular field, are dependent on physical conditions in the reservoir and on the limiting effect of economics or other imposed restrictions. Probably the most important physical factors governing potential recovery are sand permeability and oil viscosity, high permeability and low viscosity being nearly always conducive to high yield. Economic conditions determine the point at which operations must be abandoned for reasons of cost, and equally they govern decisions on optimum well spacing. As a result of their studies the committees advocate that the securing and recording of requisite data should be a major objective in field development and operation. Records required from each individual reservoir include data on structure and sand-thicknesses, complete analyses of sub-surface samples of reservoir fluids, sub-surface pressure survey readings, productivity factors, and gas, oil and water production figures.

## Introductory Magnetism and Electricity

By T. M. Yarwood. Pp. vii+159. (London: Macmillan and Co., Ltd., 1944.) 2*s*. 6*d*.

IN writing this small volume, the author has provided mainly for those preparing to enter one of the technical branches of the Services. It should be very suitable for cadets in the Air Training Corps. The subject-matter admirably covers all that is necessary in pre-service training. In this, it fulfils one of the two objects stated in the preface. It might not be, however, so successful in achieving the other, which is to stimulate further reading in the subject. It is too condensed and 'heavy-going' to be inspiring to the beginner.

It is surprising that alternating current is not dealt with at greater length. One would have expected to find a whole chapter on this topic.

The book is well arranged and well printed, with many diagrams. Its chief defect is the limp cloth binding. It is to be regretted that war-time economy does not permit a more attractive and permanent binding.

At its published price the book should have a good circulation and is, without doubt, an excellent, though brief, text, superior to many others at much higher prices.

## Manual of Laboratory Glass-Blowing

By Prof. R. H. Wright. Pp. ix+90+11 plates. (Brooklyn, N.Y.: Chemical Publishing Co., Inc., 1943.) 2.50 dollars.

IN this manual the author describes a number of processes which are constantly needed for the construction of laboratory glass apparatus. After discussing the composition and the characteristics of various glasses, a description is given of tools and their usage in the construction of both simple and advanced types of glass apparatus.

In dealing with such a subject no written directions can take the place of personal instruction or individual skill, so that the value of such a manual is enhanced if the diagrams show salient features of the process in progress. The author has attempted to do this by means of original photographs.

The book contains much useful information, and will be of service to the laboratory worker. Its usefulness would have been further increased, at least for the beginner, if more details had been given as to the most suitable gas or oxy-gas flame to use for various types of work. A. J. A.

# TRANSFORMATION OF CELLS AND VIRUSES

By Dr. ALEXANDER HADDOW

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RECENT papers by Rhoades[1] and by Sonneborn[2], the first describing a new case of genic induction of a transmissible cytoplasmic difference (the earliest example of which is due to Imai[3]), and the second concerning a novel system of relations between the nucleus and cytoplasmic substances in heredity, are of considerable potential significance for the study of differentiation and growth, both normal and abnormal. Nowhere is this greater than in the field of cancer, where the prospect they afford of a clearer understanding of cytoplasmic inheritance must elucidate some at least of the fundamental problems involved. What these problems are, may briefly be considered.

## Genetic Relationship of Normal Cells and Cancer Cells

In the entire biology of cellular variation, the transformation of normal somatic cells to cancer cells may properly be regarded as a special case, although not necessarily a unique one[4]. The alteration involves some loss of differentiation, and a nearly concomitant gain in rate of growth, the extent of which is a characteristic and permanent property of individual tumours. In ordinary conditions the change is not reversible, so that the malignant variant continues to grow, whether in the original host or on grafting to new hosts, indefinitely, without restriction, and hence with every sign of marked competitive advantage as compared with the normal form. The new cell type can be evoked at will by the use of a wide variety of physical and chemical agents (notably by X- and ultra-violet radiation, by radium and other radio-active elements, and by the carcinogenic hydrocarbons and other compounds both related and unrelated), and we now possess a considerable knowledge of their possible modes of action, of the changes they effect in the cell economy, and of the ways in which the metabolic properties of the malignant cells, in certain cases, may differ from those of their normal precursors.

Much less is known of the precise genetic relationship between the two forms. While many observers have been impressed, justifiably, by evidence which suggested the modification or loss of growth-regulating genes as a primary factor[5], these impressions are such as it is impossible to prove by ordinary genetical methods, that is, in the absence of sexual reproduction as a test. As Haldane expressed the position[6], "cancer cells do not reproduce sexually, and it is only by sexual reproduction that the geneticist can distinguish nuclear changes from plasmatic changes or virus infections".

Short of any decision, much other information, albeit of a secondary or collateral kind, or incomplete, has been derived from the study of genetic constitution as determining rates of susceptibility (whether to the spontaneous development of specific types of cancer, or to the action of carcinogenic substances), and secondly, by the production of tumours through hybridization. Thus spontaneous tumours occurring in the $F_1$ hybrids between *Nicotiana glauca* and *N. langsdorfii* have been ascribed to a cytoplasmic disturbance brought about by the introduction of chromosomes of *langsdorfii* into the cytoplasm of *glauca*[7]; and cross-breeding of *Mus musculus* and *M. bactrianus*, which differ widely from each other in size, fertility, and rate of growth, leads to a considerably augmented incidence of epithelial and connective tissue tumours in the first generation hybrids[8].

Although the nature of his material does not always allow the application of genetical methods, the student of cancer is nevertheless dependent on contemporary genetics to assist him in deciding which at least are the feasible mechanisms in the origin of tumours. To the present time, questions of detail have been wholly obscure, and it has always seemed likely that their solution must ultimately depend upon advances in cytogenetics as a whole. Furthermore, certain accepted characteristics of tumour cells have appeared, until comparatively recently, inexplicable and perplexing by ordinary tenets. This specially applies to the recognized irregularity of the chromosome equipment in cancer cells: while in given tumours no nuclear abnormality may be discernible, other cases present every appearance of extreme heterogeneity. In contrast with this is the fidelity and specificity with which the structural and physiological features of individual tumours are maintained, often through hundreds of transplanted generations, and apparently indefinitely. The matter has been summarized by Mohr[9]: "This pronounced uniformity of tumour tissue as regards phenotypical characteristics is just the opposite of what we would expect from the exceedingly variable chromosome relations of the tumour cells".

## Cytoplasm and Growth

Considerations of this kind have led some few workers[10] to the belief that malignancy is attributable to a cytoplasmic alteration, and Koller[11] carried out an analysis of aberrant chromosome and spindle mechanism in malignant cells in an endeavour to correlate this with the behaviour of the nucleolus, which appears to hold a key position in the interrelations of nucleus and cytoplasm[12]. These anomalies have also stimulated an interest in evidence from other fields, that the more general and fundamental activities of the cell can take place even in the absence of the chromosome apparatus (if only for a time), and are governed to some extent by elements present in the maternal cytoplasm. For example, evidence has been sought[13,14,15] whether cleavage-rate in echinoderms is a function of the cytoplasm or of the nucleus. In hybridization and other experiments (with Dendraster and Strongylocentrotus) the speed of fission, in every case, was that characteristic of the cytoplasm. Secondly, E. B. Harvey's studies[16] of the growth of enucleated egg fragments (for several echinoderm species and in the annelid Chætopterus) in parthenogenetic merogony, that is, where maternal and paternal chromatin are entirely lacking, appeared to modify, or even to minimize, the role of the chromosomes and genes in early development.

Since in nearly all species the properties of the cytoplasm are controlled by the chromosomes, and because cytoplasmic factors which can be perpetuated in the absence of the appropriate chromosomes have been recognized only in exceptional cases[17] and almost entirely in plants, the problem takes the form whether the capacity of the cytoplasm to determine growth is due to a chromosomal effect persisting after removal of the nucleus, or whether it is innate and independent.

## Cytoplasmic Transmission of Breast Cancer in Mice

Cognate questions arise from the so-called 'extra-chromosomal' transmission of breast cancer in mice. Since mammary cancers were found to arise with special frequencies in certain strains, attention was directed at an early stage to the presumptive importance of genetic constitution, as a factor determining the origin of such growths. The tumour-rate in hybrid strains was studied by Lathrop and Loeb[18] as long ago as 1918, when they wrote: "... the fact ... that several times (but not in all cases), in reciprocal crosses, the hybrids followed the tumour rate of the mother strain, suggests the possibility that as far as the hereditary transmission of mammary cancer in mice is concerned, the mother may be more important than the father. . . ." Much later, the role of the female sex hormone was disclosed, from records of the varying incidence of cancer in virgin, breeding and ovariectomized females, by ovarian transplantation in castrate males, and by artificial administration of œstrogens to both males and females.

Further progress followed the establishment of homozygous strains, when the importance of the maternal factor was clearly established by reciprocal crosses[19]. Bittner then discovered[20] that the cytoplasmic factor is conveyed by the mother's milk, and that when young from mothers of a high-incidence line are suckled by mothers from low-incidence lines, the frequency of breast cancer in the fostered females is very considerably reduced. It is now known that the agent is present in tumour tissue, the lactating mamma, and many of the organs of high-incidence lines, and that it retains its potency in lyophilized, desiccated or glycerolated tissue, and in Seitz filtrates. Although its exact nature is not certain, it is probably a colloid of high molecular weight[21], with properties suggesting virus activity, and may seemingly arise *de novo* apart from contact[22].

According to W. S. Murray[23], the degree of mammary cancer which appears in any generation is dependent partly upon the concentration or amount of the extra-chromosomal factor which the mother transmits, and partly upon the resistance or receptiveness of animals of various genetic constitutions to this stimulus. There still remain considerable differences of opinion regarding the relative importance to be attached to the three components (cytoplasmic, nuclear, and hormonal), whether separately or in interaction. van Gulik and Korteweg[24] apparently believe that the cytoplasmic factor becomes inactive after a number of generations when a chromosomal factor is not present at the same time. But from Bittner's most recent statement[25] hormonal stimulation, inherited susceptibility (which was transmitted by males and females of cancerous stock as a dominant), and the milk agent, are of approximately equal etiological importance in mice of known constitution under normal conditions: "that is, any one of the three factors or influences may be completely determining in its effects".

## Filterable Agents of Avian Tumours

A final problem concerns the induction of malignant change in normal connective tissue cells (more strictly the free histiocytes) in birds, by means of a submicroscopic and particulate agent extractable from the cells of tumours of the avian mesenchyme, of which the virus of the Rous chicken sarcoma I is the best known example. Tumours arising after inoculation of this and similar agents are derived from the prototype cells of the recipient host. They invariably conform in the minutest detail with the growth from which the agent was obtained, and they usually continue in their turn to produce further large amounts of the specific virus. In serological experiments[26] the purified Rous agent is neutralized by the serum of rabbits immunized with normal fowl serum or with normal fowl tissues, and stronger neutralization is obtained with the sera of rabbits immunized with large quantities of the purified agent itself. Further, both anti-fowl and anti-agent sera are deprived of neutralizing activity by absorption with normal chick embryo. The Rous I agent therefore appears to contain (in addition to a specific antigen) a second antigen which is also present in normal fowl tissue—a relationship which is possibly unparalleled in the whole range of animal viruses. The discovery of the Rous agent was made more than thirty years ago, and it represents one of the key observations of cancer research: yet here again it is likely that full comprehension can only be achieved through fundamental advance in other fields, such as is promised by the newer trends referred to, and the implications of which may be examined.

## Cytoplasmic Determinants and their Gene-controlled Mutation

Possibly the earliest relevant observation was made by Imai[3] when he described random and irreversible mutation of a proportion of green plastids (giving green cells) to white plastids (giving white cells) in the recessive 'variegated' homozygote of barley. These plastids showed maternal transmission, and the white plastids proved autonomous and independent of nuclear control or activity, since they did not return to the green condition even under the influence of the 'green' nucleus.

Rhoades's contribution[1] concerns the gene-controlled character *iojap* in maize. Plants homozygous for the recessive gene (*ij*) develop a chlorophyll striping or variegation, interpreted as due to induction, by the gene, of modification in the plastid. Evidence is given, as for Imai's case, that the modification is irreversible, that the variant plastid possesses genetic continuity, and that this is thereafter independent of nuclear control: the mutant plastid continues to give rise to mutant plastids, in cells of whatever nuclear constitution (*ij ij*, *Ij ij*, *Ij Ij*). These relations are suggestive—and Rhoades clearly recognizes their bearing—of a mechanism whereby the expression of growth, the rate of growth, and the closely associated property of degree of differentiation, might be governed by a system of independent entities in the cytoplasm.

A more complex arrangement is revealed in Sonneborn's study of the heritable characters 'killer' and 'sensitive' in diverse races of *Paramecium aurelia*. Fluid in which the killer race has lived, kills individuals of the sensitive races, and when pure races of the two types were crossed, the two exconjugants of each pair were found to produce phenotypically different clones. It was then demonstrated that the $F_1$ killer clones derive their cytoplasm from the killer parent, and that the $F_1$ sensitive clones are those with cytoplasm from the sensitive parent. By means of technically favourable material, the phenomenon was shown to be not cytoplasmic inheritance simply, but the continued production of a cytoplasmic sub-

stance under the influence of the single gene $K$. *Addition of the cytoplasmic determinant to an organism, lacking the character dependent on it, but containing the required gene, results in the continued production of the cytoplasmic substance, in the development of the character determined by the combined presence of gene and cytoplasmic substance, and in the hereditary maintenance of the character in successive generations.*

The potential significance of these relations, both for the cytoplasmic transmission of mammary cancer and the propagation by virus of the Rous sarcoma, is sufficiently striking. They also exemplify the characteristics of cytoplasmic inheritance described by Darlington[27]: "... not only co-adaptation of the types of nuclear gene and plasmagene but also some degree of genotypic control in regard to the conditions of reproduction and equilibrium of the plasmagene".

## Nature of the Cytoplasmic Entities: Plastogenes, Plasmagenes and Viruses

Apart from the visible plastids responsible for cytoplasmic inheritance in plants, the nature of the cytoplasmic entities remains a matter of conjecture. It is therefore reasonable to inquire what light may be thrown on cytoplasmic determiners by recent investigations of the morphological and chemical structure of protoplasm, and especially of the submicroscopic particles (microsomes) of Claude[28]. These range in size from 0·06 to 0·2 $\mu$, and allowing for certain quantitative differences, present many similarities to the mitochondria, and appear to serve as centres for enzyme localization, both, for example, being capable of oxidizing succinic acid and giving a reaction for cytochrome oxidase[29]. Chemically, the microsomes have been found to be complex structures composed of ribose nucleoproteins and phospholipids, associated in definite proportions. By differential centrifugation, Claude isolated the active fraction from chicken tumour extracts in a form resembling fractions obtained from normal chick embryo by the same method; and he further finds that an important and possibly essential constituent of the tumour-producing particles, as of the normal microsomes, may be a nucleic acid of ribose type. The size of the Rous agent has now been determined by electron microscopy (0·07–0·1 $\mu$), as well as in the ultracentrifuge (0·07 $\mu$)[30]. In shape the particles are short ellipsoids, and fairly homogeneous from electrophoretic behaviour.

With the suggestion of an intrinsic origin for the avian tumour viruses may be related the view that many of the plant viruses are autocatalytic proteins of ultimate host-cell origin; and both possibilities should be compared with those different but partly relevant hypotheses which envisage many viruses arising by a process of retrograde evolution, that is, by a progressive loss of enzyme systems and synthetic functions and an increasing degree of dependence upon the cellular host[31,32]. Woods and DuBuy[33] have recently brought evidence that the characteristics of plastid-controlled variegations are intermediate between those of normal plants and virus-diseased plants, and have endeavoured to connect virus proteins phylogenetically over the variegation-inducing agents (abnormal plastids) with proteins of the normal plastids. They also attempted graft transmission of plastid-controlled variegation, which would afford direct proof of the ability of abnormal plastids to infect, and invade, previously normal cells. Although these experiments were mainly negative, such graft invasion has already been established as the cause of variegation in a number of plant species, and there is little reason to doubt that variegation-inducing plastids frequently behave like viruses, just as the plant viruses have properties often shown by plasmagenes in interspecific crosses[27]. In particular, it is likely that the changes evoked by many viruses are due to their competing for substrate with physiological elements of the cell, and thus diverting the normal metabolism. From Darlington's interpretation of Sonneborn's data[41], the 'sensitive' plasmagene in Paramecium, which is determined by the action of a nuclear gene, is suppressed by the competitive reproduction of another plasmagene. So too the variegation-inducing plastids can multiply in previously normal cells, and may restrict the development of normal plastids in those cells. The manner in which the influence of plant viruses can be likened to that of agents already present had already been noted by Stanley[34].

## Induction of Heritable Change in Bacteria and Viruses

Sonneborn compared the system of determination and inheritance in Paramecium with the environmental control of genetic characters in bacteria, especially with the inter-conversion of specific types of Pneumococcus. This phenomenon was first described by Griffith[35], and it depends upon the degradation of a given specific, virulent, 'smooth' type ($S$), possessing the characteristic capsule with its specific polysaccharide antigens, into a non-specific, avirulent, 'rough' variant ($R$), lacking these features but convertible into the same or another specific and differentiated type ($S$) by growth in the presence of heat-killed $S$ cells of the type to which conversion is desired. The transformation was afterwards induced by means of sterile extracts of $S$ cells[36], and represents one of the most striking examples of the artificial induction of heritable change. The agent required for conversion was recognized to be not the specific polysaccharide itself, but some other component of the $S$-type cell, and Avery and his co-workers[37] have now isolated from type III pneumococci a desoxyribonucleic acid fraction which is capable of transforming unencapsulated $R$ variants (derived from type II pneumococci) into fully encapsulated type III cells: the inducing substance appears to be a highly polymerized form of sodium desoxyribonucleate. It is a striking fact that the substance evoking the reaction, and the type-specific capsular substance produced in response to it, are chemically distinct. Once transformation has occurred, the newly acquired characteristics are thereafter transmitted without any further addition of the transforming agent; and from the transformed cells themselves a substance of identical activity can be recovered in amounts far in excess of that originally added, or needed, to induce the change. Assuming the transforming activity to be an inherent property of the nucleic acid, its biological specificity remains to be explained on a chemical basis. Little is known of the effects which slight differences in molecular configuration may exert on the biological action of this class of compound, although the constituent units and general structure of the nucleic acid molecule have been defined: this in itself must represent an entirely new and highly promising field.

A similar principle probably obtains for certain virus transformations. Berry[38], applying the methods discovered by Griffith, succeeded in changing the virus of rabbit fibromatosis (Shope)—in which the

lesions consist of masses of spindle-shaped cells which may recall the structure of malignant connective tissue tumours—into that of infectious myxomatosis (Sanarelli), a highly contagious disease in which tumour-like formations appear in the sub-epidermal tissues, and in which the type cell is not spindle-shaped but stellate or polygonal. In this case, however, the reaction is initiated only with difficulty, and a large excess of the transforming factors is required. A serological connexion between the fibroma and myxoma agents had already been noted, and it would seem that the immunological configuration of the killed myxoma virus particle remains sufficiently intact to provide a template for the formation of active myxoma virus, in the presence of a developing fibroma lesion. This specific mutability is a property of a considerable number of strains of fibroma virus, and the capacity of various myxoma strains to serve as transforming agents also seems to be both general and stable. The factor which induces the alteration of fibroma to myxoma virus is an integral part of the so-called elementary bodies of the latter, and Berry records a number of facts suggesting that the essential substance is the myxoma virus nucleoprotein. The transformation itself has emphasized the close relationships in a single group of viruses, which has been called the fibroma-myxoma 'spectrum', and which is capable of exciting the most widely diverse pathological effects.

## Reversibility of Cellular Changes

By a few workers (for example, Dobzhansky[39]), pneumococcal transformation has been interpreted on genetic lines, the inducing substance (only later recognized as probably a desoxyribonucleate) being likened to a gene, and the capsular antigen which is produced in response to it being regarded as a gene product. The subject has also been of considerable interest to those engaged in the investigation of cancer, and Murphy[40] compared it with the virus propagation of fowl tumours, and coined the term 'transmissible mutagen' to describe the Rous and similar agents. This analogy with a mutation-producing gene is, however, only valid in a general sense, and proves less accurate in points of detail. Thus most observers have been impressed not by any resemblance of $R \rightarrow S$ transformation of pneumococci and the conversion of normal cells into malignant cells, but by the affinities of the latter process with irreversible $S \rightarrow R$ changes in bacteria. Hence, if the Rous virus corresponds with a cytoplasmic determiner, the factor inducing pneumococcal transformation conforms rather with the gene, and it converts a less differentiated cell into a highly type-specific form.

Other points of contrast arise from the differing reversibility of the two changes. Although the susceptible normal cell can easily be rendered malignant on infection with the chicken tumour virus, the tumour cell then continues to breed true, and cannot be re-converted to the normal. For certain instances of bacterial variation the $R$ and $S$ forms are mutually convertible, as we have seen; but in the majority, the $S \rightarrow R$ change is induced with greater facility than the reverse, and in many cases the $R$ type is highly stable, or even permanently so. Sonneborn provides some insight into such relationships from a consideration of the relative mutation-rates, killer $\rightarrow$ sensitive, and sensitive $\rightarrow$ killer, in Paramecium. Mutations from killer to sensitive are expected more frequently than in the reverse direction, since they will occur either if the cytoplasmic factor is lost, or if the gene mutates to a form that cannot control production of the cytoplasmic factor. Contrariwise, mutation from sensitive to killer, in those cases in which the sensitive gene is present, requires both mutation of the gene and *de novo* origination of the cytoplasmic factor. Therefore, mutation in the former direction involves either of two events, while mutation in the latter direction necessitates two events in a given order.

## Implications for Growth and Infection

For the larger questions of genetics and heredity, Darlington[41] has shown the significance, and the stages in its discovery, of a positive influence of the cytoplasm which is based upon unattached determinants, vested in a molecular system depending for its permanence upon a chemical rather than a morphological equilibrium, and which shows a limited capacity for independence of the mechanically stable nucleus. As he makes clear, knowledge of the plastid and cytoplasmic systems was necessarily delayed, and is only now unfolding, since it could only be interpreted in terms of a prior understanding of the nuclear system. The new conceptions are equally certain to produce their impact upon almost every other department of thought in biology, not least in the special problems of the nature of viruses, and of growth and differentiation—problems which have indeed awaited just such an advance, for their proper development.

So far as infection is concerned, it may be recalled that the progress of bacteriology itself involved a not inconsiderable readjustment of ideas. But its spectacular rise as an applied science induced in turn a prevalent unwillingness to regard any agents with biological activity of the nature of infection (and particularly the filterable viruses) as other than entirely specific and independent living organisms. In course of time there gradually accumulated a body of facts, concerned, it is true, with only a few classes of these filterable entities, such as the plant viruses and the avian tumour agents, which nevertheless appeared inconsistent with this orthodox view. Little difference of opinion has ever centred on the validity of the facts themselves: the antithesis is one of theory, and not of observation. The comprehension of anomalous cases was therefore hindered by a too limited interpretation. It is in this sense that the newer development has significance, in facilitating understanding, and on a basis sufficiently wide to include data hitherto appearing incomprehensible, or even irreconcilable. Apart from any question of identity of nature, parallels had already been drawn between the *kinetics* of gene action and virus production[42], and between the X-ray or ultra-violet inactivation curves of both viruses and genes[43]. But in certain cases similarity of behaviour becomes identity, and, for the Rous agent at least, no real distinction can be drawn between its typical activity and that of a mutant plastogene. Especially, this suggestion would account for the strict cytotropic specificity of fowl sarcoma agents, by which each transmits to the new host the characters of that particular tumour alone from which it was obtained.

## Virus Etiology of Cancer in General

This broadened interpretation, valuable as it must prove to be, still affords no rationale of the curious distribution of non-cellular agents in the induction

and transmission of cancer. An agent of the Rous type may not be detected invariably, even in the Rous I tumour, its presence and absence being to some extent correlated with more rapid and less rapid growth of the cells, respectively. Other spontaneous connective tissue tumours of the fowl may completely fail to exhibit such an agent. Again, a comparable agent has not been found in any epithelial tumour, but only in those from avian mesoblast and the type cells of chicken leukæmia[44]. Finally, no such agent is present in malignant mammalian tumours, with the possible exception of leukæmia in mice. Attempts have been made to trace the source of this contrast between avian and mammalian tumours to some inherent cellular difference in the two classes. So far, the only distinction observed is a marked size-variation in avian chromosomes, the smallest particles in the metaphase plates being on the limit of resolution: this range was regarded by White[45] as characteristic of birds in general and quite unparalleled elsewhere.

Indications of infection in the natural history of cancer have rightly attracted considerable notice; but the great mass of fact shows them to be exceptional, and gives little hint of any such process as an indispensable feature of the induction of tumours. In particular, the zoological distribution of the disease —and the occurrence of somewhat analogous tumours in plants—is so wide as to lead us to suspect that the neoplastic change, by which the somatic cell, as it were, re-asserts its individuality, has in its nature something fundamental in biology, and is one to which almost every cell is liable in appropriate circumstances, quite apart from any process of infection in the bacteriological meaning, by independent and unrelated parasitic organisms. The entire evidence which might show that the avian tumour agents are independent parasites relies mainly on their unlimited capacity for multiplication in the presence of susceptible living cells either *in vivo* or *in vitro*, on the fact that cell-free filtrates of certain of the fowl tumours have been found to induce similar tumours in other avian species[46], and on analogy with proliferative although non-malignant lesions, in man and animals, caused by acknowledged viruses in the older sense[47] (for example, the pox diseases epithelioma contagiosum and molluscum contagiosum, the filterable warts of man, dogs and cattle, and infectious papillomatosis of rabbits). The last comparisons are admittedly compelling, but the other criteria have proved less easy to maintain. The first (capacity for multiplication) can clearly no longer be accepted as necessarily attesting the living or extrinsic nature of the material undergoing increase.

Significance has also been attached to the transmission of the Fujinami fowl myxosarcoma to ducks and of the Rous I sarcoma and a fowl endothelioma by filtrate to pheasants, but it is pertinent[48] that transmission in both of these cases is still within the limits of blood relationship as judged by the precipitin reaction: moreover, propagation to the pheasant is within the limits not only of blood relationship but also of bastardization. (Apart from modern examples, it is of interest that Darwin made reference to *phasianus* × *gallus* hybrids in Chapter 9 of the "Origin of Species".) The successful transmission of a fowl tumour to pheasant or duck does not therefore make it less likely that the filterable agent is a cell-derivative on one hand, or more likely that it is an independent parasitic virus on the other.

The discovery of the plasmagene would have held a special interest for Boycott, who always found it difficult to escape the conclusion that the Rous agent arises intrinsically and *de novo*, and who said on a memorable occasion, "if one postulates a normal virus occurring in normal cells, one had better call it something other than a virus"[49].

## Cytoplasm and Differentiation

Both Rhoades and Sonneborn are aware of the implication of their findings for differentiation, in explanation of the fact that while all the cells of an organism presumably have the same genetic constitution in the nucleus, they nevertheless exhibit wide morphological and physiological differences, which are not entirely due to differences in tissue environment: and the view is put forward[1] that cellular differentiation is determined by hypothetical particles in the cytoplasm. The production of different characters in cells with the same nuclear genes would thus be brought about by differential segregation of these cytoplasmic determiners at cell division[2] in a manner similar to that which governs the segregation of plastids. As has been emphasized, the question of differentiation is paramount in the study of cancer. The cells of a given tumour usually show some degree of structural and functional affinity to their normal parent cells: so a cancer of the breast may possess a glandular structure obviously related to the architecture of the normal organ, the cells of a cancer of the liver may retain a considerable degree of resemblance to normal liver cells, and tumours of secretory organs may continue to elaborate the characteristic product, whether hormone or enzyme, of their normal prototype. In general, however, the change from a normal to a malignant cell connotes some loss of special functions, and the tumours of a given lineage can be placed in a continuous series ranging from a near-perfect reproduction of the histology of the parent tissue to a condition in which no specific differentiation can be recognized whatever[50]. The extent of such departure is relatively stable for any given tumour, and the greater it is, the nearer (in many cases but by no means invariably) does the new cell tend to approach an embryonic type and the greater is its rate of growth.

These old and new facts, taken together, suggest a means whereby light may be shed on the central problem of the mode of action of carcinogenic agents other than virus-like influences; that is, the chemical carcinogens obtained by synthesis or from sources outside the body. In our approach to this problem one salient fact overshadows all others: that the growth of the tumour is not in any sense dependent upon the continued presence of the agent which provoked it. In other words, the chemical carcinogen produces a change in the habit of growth of the cell, but as the change is quite permanent, it persists indefinitely after the initial cause has disappeared or has been removed. It is patent that the carcinogen does not provide the real stimulus to growth, since growth proceeds without it. Hence the mechanism which permits unlimited growth must clearly reside in the cell itself. That it may reside partly at least in the cytoplasm, and conceivably in relation to the considerable quantities of ribose nucleic acids which the studies of Brachet, Caspersson and others have shown to be present there when rapid synthesis is taking place, is obviously a possibility for future investigation, both by cytological methods and by experiment.

The new discoveries have, therefore, the widest implications, and for specialized matters no less than for those of a more general nature. In many cases the relationships seem more than mere analogies, and strongly suggest an underlying unity of principle in the growth and differentiation of organisms of the most highly diverse kinds. They also testify to the particular value, notwithstanding its recognized limitations, of the study of variation in unicellular organisms, and sustain the belief, long held by Dobell and others, and now more widely shared, that more than one of the current conceptions in biology must undergo profound modification as a result.


1 Rhoades, M. M., *Proc. Nat. Acad. Sci.*, **29**, 327 (1943).
2 Sonneborn, T. M., *Proc. Nat. Acad. Sci.*, **29**, 329, 338 (1943).
3 Imai, Y., *Genetics*, **13**, 544 (1928).
4 Haddow, A., *Acta de l'Union internat. contre le cancer*, **2**, 376 (1937).
5 Jones, D. F., *Amer. Nat.*, **70**, 86 (1936).
6 Haldane, J. B. S., *Nature*, **132**, 265 (1933).
7 Whitaker, T. W., *J. Arnold Arboretum*, **15**, 144 (1934).
8 Little, C. C., *Proc. Nat. Acad. Sci.*, **25**, 452 (1939).
9 Mohr, O. L., "Heredity and Disease" (New York, 1934).
10 Lewis, W. H., *Science*, **81**, 545 (1935).
11 Koller, P. C., *Nature*, **151**, 244 (1943).
12 Schultz, J., Caspersson, T., and Aquilonius, L., *Proc. Nat. Acad. Sci.*, **26**, 515 (1940). Gates, R. R., *Bot. Rev.*, **8**, 337 (1942).
13 Moore, A. R., *J. Exp. Biol.*, **10**, 230 (1933).
14 Moore, J. A., *J. Exp. Zool.*, **86**, 405 (1941).
15 Francesco, C. de, *Pubbl. d. Staz. Zool. Napoli*, **13**, 279 (1933).
16 Harvey, E. B., *Biol. Bull.*, **71**, 101 (1936); **76**, 384 (1939).
17 Waddington, C. H., "An Introduction to Modern Genetics" (London, 1939).
18 Lathrop, A. E. C., and Loeb, L., *J. Exp. Med.*, **28**, 475 (1918).
19 Staff of the Roscoe B. Jackson Memorial Laboratory, *Science*, **78**, 465 (1933).
20 Bittner, J. J., *Science*, **84**, 162 (1936); *Publ. Health Repts., Washington*, **54**, 1827 (1939).
21 Visscher, M. B., Green, R. G., and Bittner, J. J., *Proc. Soc. Exp Biol. Med.*, **49**, 94 (1942).
22 Bittner, J. J., *Cancer Research*, **2**, 710 (1942).
23 Murray, W. S., *Proc. 8th Amer. Sci. Congr.*, **6**, 431 (1942).
24 Gulik, P. J. van and Korteweg, R., *Verslagen Nederl. Akad. van Wetenschappen*, **40**, 891 (1940).
25 Bittner, J. J., *Cancer Research*, **4**, 159 (1944).
26 Amies, C. R., Carr, J. G., and Ledingham, J. C. G., *Rept. Proc. 3rd Internat. Congr. Microbiol.*, New York, 335 (1940).
27 Darlington, C. D., "The Evolution of Genetic Systems" (Cambridge 1939).
28 Claude, A., *Proc. Soc. Exp. Biol. Med.*, **39**, 398 (1938); *Science*, **87**, 467 (1938); **90**, 213 (1939); **97**, 451 (1943); *Biol. Symposia*, **10**, 111 (1943).
29 Lazarow, A., *Biol. Symposia*, **10**, 9 (1943).
30 Stern, K. G., *Biol. Symposia*, **10**, 291 (1943).
31 Green, R. G., *Science*, **82**, 443 (1935); in "Chemistry and Medicine" (Minneapolis, 1940).
32 Laidlaw, P. P., "Virus Diseases and Viruses" (London, 1938).
33 Woods, M. W., and DuBuy, H. G., *Phytopathology*, **33**, 637 (1943). **33**, 766 (1943).
34 Stanley, W. M., *Physiol. Rev.*, **19**, 524 (1939).
35 Griffith, F., *J. Hyg.*, **27**, 113 (1928).
36 Alloway, J. L., *J. Exp. Med.*, **55**, 91 (1932); **57**, 265 (1933).
37 Avery, O. T., McLeod, C. M., and McCarty, M., *J. Exp. Med.*, **79**, 137 (1944).
38 Berry, G. P., and Dedrick, H. M., *J. Bact.*, **31**, 50 (1936). Scherp, H. W., Berry, G. P., and Shaw, D. R., *Federation Proceedings*, **1**, 183, (1942).
39 Dobzhansky, T., "Genetics and the Origin of Species" (New York, 1941).
40 Murphy, J. B., *Trans. Assoc. Amer. Physicians*, **46**, 182 (1931); *Bull. Johns Hopkins Hosp.*, **56**, 1 (1935).
41 Darlington, C. D., *Nature*, **154**, 164 (1944).
42 Goldschmidt, R., *Proc. Nat. Acad. Sci.*, **23**, 219 (1937).
43 Gowen, J. W., Proc. 7th Internat. Genet. Congr., Edinburgh, 133 (1940).
44 Furth, J., *J. Exp. Med.*, **58**, 253 (1933). Rothe-Mayer, A., and Engelbreth-Holm, J., *Acta path. et microbiol. Scand.*, **10**, 380 (1933).
45 White, M. J. D., *J. Genetics*, **26**, 345 (1932). Painter, T. S., and Cole, L. J., *J. Morph.*, **72**, 411 (1943).
46 Andrewes, C. H., *J. Path. Bact.*, **35**, 407 (1932).
47 Andrewes, C. H., *Lancet*, ii, 63, 117 (1934).
48 Haddow, A., *Lancet*, ii, 217 (1934).
49 Boycott, A. E., *Proc. Roy. Soc. Med.*, **22**, 55 (1929); *Proc. Roy. Soc.*, B, **113**, 291 (1933).
50 Murray, J. A., *Proc. Roy. Soc.*, B, **113**, 268 (1933).


# RECENT DEVELOPMENTS IN POLAROGRAPHIC ANALYSIS


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ALTHOUGH almost twenty years have passed since the polarograph was devised by Prof. J. Heyrovský and his colleagues at the Charles University in Prague, it has only been during the last two years that use of the instrument has been widely accepted by industrial laboratories in Great Britain. Nevertheless, it is now generally agreed that the instrument is of unquestionable value, and the polarograph is taking its place in the equipment of the modern laboratory along with the spectrometer and photo-electric absorptiometer.

The fundamental principles of polarographic analysis were worked out in Prof. Heyrovský's laboratory and have since been confirmed in the United States. These principles are fully described in an excellent monograph by Kolthoff and Lingane[1] which surveys the literature of polarography up to the end of 1940. Since that date, many new applications have been developed, especially in the biological and organic fields, and it is these that I propose to survey.

Polarographic analysis depends essentially on the fact that when a gradually increasing potential is applied to an electrolyte solution in a special cell consisting of a dropping mercury electrode and a second non-polarizable electrode, it is possible to determine from the resulting current-voltage curve both the nature and the concentration of the reducible or oxidizable substance or substances present. It is these current-voltage curves that are recorded by the polarograph.

A typical polarogram obtained with an air-free solution of $0 \cdot 001\,M$ cadmium chloride in $0 \cdot 1\,N$ potassium chloride is shown in Fig. 1. Under standard conditions, the limiting or diffusion current (that is, the height of the step) is proportional to the concentration of the electroreducible substance. This serves as the basis of quantitative polarography. The half-wave potential, which, as its name implies, is the value of the potential of the dropping mercury electrode, standardized against an external reference electrode (usually the saturated calomel electrode), at that point on the current-voltage curve when the current is one-half its limiting value, is a special property of the particular electroreducible substance present and is independent of the concentration of

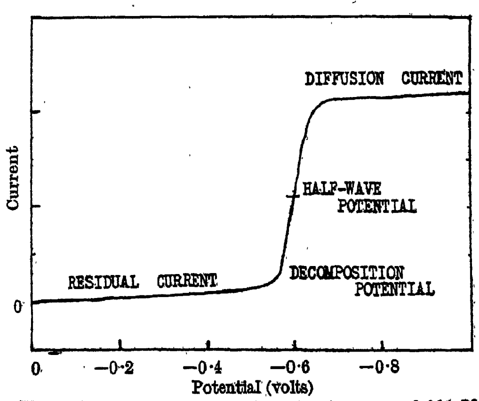



Fig. 1. CURRENT-VOLTAGE CURVE FOR SOLUTION OF $0 \cdot 001\,M$ CADMIUM CHLORIDE IN $0 \cdot 1\,N$ POTASSIUM CHLORIDE.

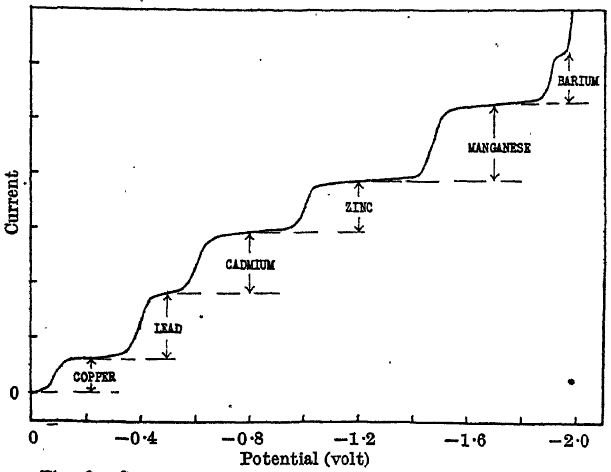



Fig. 2. CURRENT-VOLTAGE CURVE FOR SOLUTION CONTAINING COPPER, LEAD, CADMIUM, ZINC, MANGANESE AND BARIUM IN 0·1 $N$ CALCIUM CHLORIDE.

the substance and of the characteristics of the electrode used. Qualitative polarography is based on this conception.

Theoretically, every substance can be analysed polarographically if it is electro-reducible or -oxidizable within the potential range of the electrode. The maximum range of the dropping mercury electrode is from + 0·6 to − 2·6 V. *v.* the saturated calomel electrode; but for most solutions it is much smaller. If there are several electro-active substances present in the solution, they can all be estimated, provided that their half-wave potentials are at least 0·2 V. apart. Fig. 2 shows a polarogram for a solution containing traces of copper, lead, cadmium, zinc, manganese and barium in 0·1 $N$ calcium chloride. A further separation of steps can sometimes be achieved by altering the $p$H of the solution or by changing the reactants into complexes, from which they are deposited at potentials far enough apart for each step to be measured separately.

The diffusion current is governed by Ilkovič's equation,

$$i_d = knD^{1/2}\, Cm^{2/3}\, t^{1/6},$$

in which $i_d$ is the diffusion current in microamperes, $n$ is the number of faradays of electricity required per molar unit of the electrode reaction, $D$ is the diffusion coefficient of the reducible or oxidizable substance in sq. cm. per second, $C$ is its concentration in millimoles per litre, $m$ is the weight of mercury in mgm. flowing out of the capillary per second, and $t$ is the drop time in seconds.

It has been deduced from theoretical considerations that the constant $k$ should be equal to 605 at temperatures between 15° and 40° C. The approximate correctness of this value has been verified experimentally in the few cases where sufficiently accurate values of diffusion coefficients are available to permit a comparison. In most instances, however, this theoretical constant cannot be used to calculate diffusion current constants with any degree of accuracy, since diffusion coefficient data for the conditions existing in polarographic measurements are not to be found in the literature. These constants must therefore be determined experimentally.

The other factors to be considered in quantitative polarography have been discussed by Kolthoff[2], who has also directed attention to an anomalous 'water wave', which occurs in solutions containing a relatively high concentration of a supporting electrolyte. This step usually starts at about − 0·9 V. and reaches a maximum at − 1·3 V.; but fortunately it can readily be eliminated by adding a trace of gelatin to the solution.

Several investigators have tried to develop schemes of polarographic analysis that would permit the systematic qualitative and quantitative analysis of any mixture of the common metallic elements, but before such a scheme can be developed it is necessary to obtain detailed information about the behaviour of each of the elements under different conditions. Recently, Lingane[3] has published such data for arsenic, antimony, bismuth, tin, lead, cadmium, zinc and copper in various supporting electrolytes, and has pointed out that if the diffusion current constant of a metal is known, there is no need to calibrate each dropping mercury electrode with known concentrations of the metal, provided that the characteristics of the particular electrode are also known.

The polarographic method is widely used in metallurgical analysis for determining trace metals in alloys; but it may equally be applied to the inorganic constituents of a host of other materials ranging from tap-water to various biological products. Since many organic substances are themselves reducible at the dropping-mercury electrode, it is frequently necessary to prepare the biological samples for analysis by special pre-treatments. Such methods have been described for the determination of lead[4], arsenic[5], and vanadium[6].

A special application[7] of the technique has been used for the measurement of ter- and quinque-valent antimony in blood and urine when studying the metabolism of the therapeutic antimony compounds employed in the treatment of bilharziasis and kala-azar. Using ordinary chemical methods, it is difficult to distinguish between ter- and quinque-valent antimony in biological material. However, ter- but not quinque-valent antimony in normal hydrochloric acid solution forms a good polarographic step with a half-wave potential *v.* the saturated calomel electrode at − 0·15 V. (cf. Fig. 3) and consequently can readily be determined in the presence of the quinque-valent form. The latter can be determined after reduction with sodium sulphite. The procedure proved to be surprisingly rapid as well as accurate, so that it was possible to make a large number of measurements, which would have been impracticable by earlier methods. Samples of blood needed relatively little pre-treatment, and urine could be examined directly. Since the half-wave potential for ter-valent antimony is relatively low at − 0·15 V. *v.* the saturated calomel electrode, its characteristic step appears before those due to the other reducible substances in urine. The steps formed by the latter substances would completely mask those produced by small quantities of a substance less readily reducible than ter-valent antimony. A similar procedure may be adopted for the determination of bismuth.

Oxygen dissolved in electrolyte solutions is reduced at the dropping-mercury electrode and yields two distinct steps, the first step being due to the reduction of oxygen to hydrogen peroxide and the second to the reduction of hydrogen peroxide, either to water or hydroxyl ion. The second step coincides with that obtained for the electrolysis of an air-free solution of hydrogen peroxide. These oxygen steps have been extensively used for measuring the oxygen content of a wide range of materials, including body fluids[8],

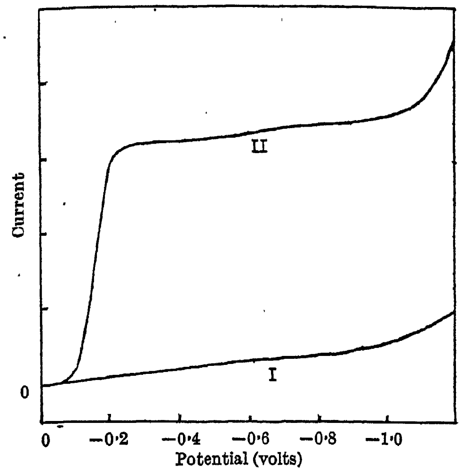



Fig. 3. CURRENT-VOLTAGE CURVE FOR ANTIMONY. I, 0·0001 *M* SODIUM QUINQUEVALENT ANTIMONY GLUCONATE; II, 0·0001 *M* SODIUM TERVALENT ANTIMONY GLUCONATE.

technical gases, activated sludge and lake water, and for studying the photosynthesis- and respiration-rates of micro-organisms.

The polarograph is of considerable theoretical importance for the study of oxidation-reduction systems. An ideal example of a reversible reduction at the dropping-mercury electrode is given by quinhydrone and its components. In a well-buffered solution, the step due to the reduction of benzoquinone has the same characteristic half-wave potential as the step due to the oxidation of hydroquinone. If quinhydrone is examined, one half of the curve represents an oxidation of hydroquinone at the mercury anode, while the other half represents a reduction of benzoquinone at the mercury cathode. An oxidation-reduction system is thermodynamically reversible if identical polarographic half-wave potentials are obtained for the reduction of the oxidant and oxidation of the reductant. As would be expected, values for the oxidation-reduction potentials[9,10] of such systems determined polarographically are in good agreement with those obtained by the classical methods.

The electrolytic examination of most organic substances involves reactions which are not thermodynamically reversible, since products are formed which cannot be oxidized or reduced to give the starting material at the same electrode potential. The reductions of aldehydes, ketones, unsaturated acids and nitro-compounds belong to this group.

The polarographic behaviour of the various vitamins which contain reducible groupings has been studied extensively. Aneurin (thiamin; vitamin $B_1$), riboflavin, nicotinic acid, pantothenic acid, ascorbic acid (vitamin C), α-tocopherol (vitamin E) and vitamin K can be determined in pure solution, but further work is required before they can be estimated in the presence of other reducible substances. Cholesterol[11] and other constituents of fish liver oils interfere with the polarographic determination of α-tocopherol. The mechanism of the riboflavin step has been investigated further by Brdička and Knoblock[12].

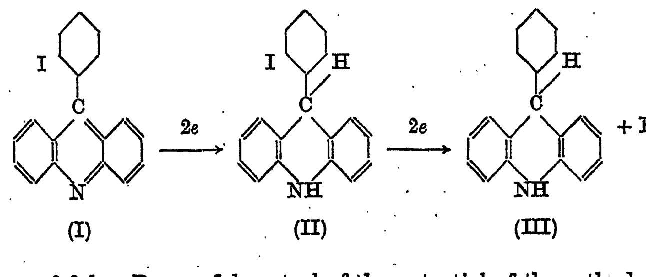
The dropping-mercury electrode can be used for the determination of certain sex hormones[13]: α : β-unsaturated keto-steroids (for example, testosterone, progesterone, corticosterone, and desoxycorticosterone) are reducible, while the 17-ketosteroids (for example, androsterone and *iso*androsterone) are not. Nevertheless, the latter may be condensed with excess Girard reagent *T* (trimethyl acethydrazide ammonium chloride) to yield derivatives which have an electro-active molecule. The steps are well defined and can be used for the determination of the different ketosteroids in urine extracts; but unfortunately the method cannot be applied to mixtures of ketosteroids as the individual steps are too close together.

Kolthoff and his colleagues[14] have started a polarographic investigation of the sulphonamides with the view of testing theories as to their mode of action. Oxidation products of sulphonamides[1] such as *p*-hydroxylaminobenzenesulphonamide, *p* : *p'*-azoxybenzenesulphonamide and *p*-nitrobenzenesulphonamide are electro-reducible at the dropping-mercury electrode.

In addition to reversible and irreversible direct reductions, catalytic reductions may also occur at the dropping-mercury electrode. Brdička[15] observed that if sulphur-containing proteins were reduced in a buffered cobalt or nickel solution, a large double step formed. Cystine and cysteine behaved in the same way, but only gave a single large step. Since these special steps were not obtained in the absence of cobalt and nickel, Brdička concluded that the hydrogen evolution from the sulphhydryl groups is catalysed by the metals.

The curious behaviour of these catalytic steps attracted considerable attention. When blood proteins from different individuals were examined, it was noticed that serum from cancer patients gave a much smaller protein double step than that resulting from the serum of normal patients. This phenomena appeared to offer great possibilities for the diagnosis of cancer, but unfortunately it has since been found[16] that sera from patients suffering from pneumonia and arthritis show a similar effect.

The polarographic method may be used in synthetic organic chemistry to select the best conditions for carrying out electrolytic preparations at controlled potentials. Lingane, Swain and Fields[17] found that the reduction of 5-(*o*-iodophenyl)-acridine (I) proceeds in two stages, first to 5-(*o*-iodophenyl)-dihydroacridine (II) and then to 5-phenyl-dihydroacridine (III) with elimination of iodine, the reduction potentials at the mercury cathode of the two stages being separated by about 0·3 V.




By careful control of the potential of the cathode, it was possible to prepare either compound (II) or (III) in a high state of purity and in almost quantitative yield. The method should be of particular value whenever the selective oxidation or reduction of only one out of two almost equally reactive groupings in a molecule is required.

There is no room in this short account of recent research with the polarograph to deal with the rapidly growing field of amperometric titrations, which has been developed so extensively by Kolthoff and his collaborators at the University of Minnesota. Nevertheless, it is hoped that sufficient material has been incorporated to indicate the versatility of the polarograph and the general usefulness of polarography.

[1] Kolthoff, I. M., and Lingane, J. J., "Polarography" (Interscience Publishers, New York, 1941).
[2] Kolthoff, I. M., *Ind. Eng. Chem.* (Anal. Ed.), **14**, 195 (1942).
[3] Lingane, J. J., *Ind. Eng. Chem.* (Anal. Ed.), **15**, 583 (1943).
[4] Read, G., and Gant, V. A., *Indust. Med.*, **11**, 107 (1942).
[5] Bambach, K., *Ind. Eng. Chem.* (Anal. Ed.), **14**, 265 (1942).
[6] Page, J. E., and Robinson, F. A., *Analyst*, **68**, 269 (1943).
[7] Goodwin, L. G., and Page, J. E., *Biochem. J.*, **37**, 198 (1943).
[8] Beecher, H. K., Follansbee, R., Murphy, A. J., and Craig, F. N., *J. Biol. Chem.*, **146**, 197 (1942).
[9] Smith, L. I., Kolthoff, I. M., Wawzonek, S., and Ruoff, P. M., *J. Amer. Chem. Soc.*, **63**, 1018 (1941).
[10] Page, J. E., and Robinson, F. A., *J. Chem. Soc.*, 133 (1943).
[11] Beaver, J. J., and Kaunitz, H., *J. Biol. Chem.*, **152**, 365 (1944).
[12] Brdička, R., and Knoblock, E., *Z. Electrochem.*, **47**, 721 (1941); **48**, 686 (1942).
[13] Hershberg, E. B., Wolfe, J. K., and Fieser, L. F., *J. Biol. Chem.*, **140**, 215 (1941).
[14] Levitan, N. I., Kolthoff, I. M., Clark, W. G., and Tenenberg, D. J., *J. Amer. Chem. Soc.*, **65**, 2265 (1943).
[15] Brdička, R., *Coll. Czech. Chem. Commun.*, **5**, 112, 148, 238 (1933).
[16] Müller, O. H., *Amer. J. Physiol.*, **133**, P 373 (1941).
[17] Lingane, J. J., Swain, C. G., and Fields, M., *J. Amer. Chem. Soc.* **64**, 1348 (1943).

## DIETARY STUDIES IN GREAT BRITAIN

THE lecture theatre at the London School of Hygiene and Tropical Medicine was well filled for the second part of the conference arranged by the Nutrition Society on "Budgetary and Dietary Surveys of Families and Individuals" held on May 20; and it remained full, practically to capacity, until the end. That there is an extraordinary and intense interest in the problems of nutrition, awakened largely as the result of the War, but drawing on the experience of those trained in nutritional problems during the War of 1914–18 and since, was manifest. Every paper was followed with close attention, though humour, conscious or unconscious —one member spoke of his "cooked figures"—received its reward.

The first part of the conference, held on February 5 (see *Nature*, March 11, p. 306), dealt with the practical and theoretical problems involved in making dietary surveys; the accuracy and the statistical validity of such surveys and the interpretation of results. The second part of the conference dealt with the results of surveys obtained by the individual, the group, the reminiscent and housekeeping methods, though no budgetary surveys were given. It was clear that each protagonist was satisfied with the method he adopted and inclined to doubt the validity of the other methods. Also it was clear that the Nutrition Society is bowing its knee to the Dagon of statistics, possibly with too little care to see that the figures before 'manipulation' approximate to reality. However that may be, there were gathered together a large number of people willing and able to bring their scientific ability to bear on the problem of feeding the people in the optimal way.

The chairman, Dr. J. Hammond, opened with almost the fewest possible remarks, and called on Miss E. M. Widdowson and Dr. R. A. McCance (Department of Medicine, University of Cambridge) for their paper on dietary surveys by the individual method. The paper was based by Miss Widdowson on the dietary surveys of more than a thousand middle-class children in the years before this War, on some recent surveys, and on figures already reported for 63 men and 63 women. The problem was to obtain the figures and then to 'manipulate' them. The figures were obtained by the weighing of foods at table by intelligent, though not necessarily laboratory-trained, people. In calculation, tables for cooked, not raw, foods were taken. When results from tables were compared with actual laboratory analysis, there was not much difference, except in calcium and iron. The calcium and iron were higher in analysis as the result of tap-water cooking and contamination of the foods with iron from knives, saucepans and mincing machines. A week's survey is sufficient, but there are huge daily fluctuations in intake. The results obtained from the thousand children show almost as great a deviation from the mean as those of the 63 men and 63 women. At any age, one child in that age group might be eating twice as much as another in that same group. A boy of two years might be eating more of some dietary constituent than one of seventeen; protein and vitamin $B_1$ increase with age, calcium and vitamin C remain constant or fall as the age increases. Boys of fourteen ate four times as much meat as those of four, but only twice as many potatoes. Family and individual dietaries should be carried out side by side. If a family is getting its 'right' quota, but father is taking 4,500 calories, then the rest of the family (say mother and son) are being underfed.

Prof. V. H. Mottram (King's College of Household and Social Science, University of London) agreed that the man-value story has proved useless and should be buried. He believed that all this work points back to the calorimeter. The daily fluctuations cancel out in a group, so that a day's intake is sufficient guide. Prof. J. R. Marrack (London Hospital Medical School) asked what was done about made dishes which might vary in cooking, and suggested that the histories of these children who over- or under-fed should be followed up.

Dr. F. C. Happold (University of Leeds) said that the determination of expenditure of energy by medical students agrees with both weighed and estimated food intakes with small standard deviation. Others asked whether the readers' figures had been analysed statistically and whether colds did not alter food intake. Mr. A. L. Bacharach (Glaxo Laboratories) pointed out that what children eat is not necessarily a measure of what they ought to eat. In reply, Miss Widdowson admitted that made dishes are the nightmare of dietary surveys, minor ailments do influence food intake, though minor ailments are part of ordinary life and that her figures had been submitted to statistical manipulation. Dr. Gertrude Wagner (Wartime Social Survey) gave the results of surveys of methods used in preparing and cooking food. These investigated the ways in which people in different parts of England buy and prepare vegetables. 2,600 interviews were made. 100 per cent of families take potatoes, 90 per cent 'greens', 80 per cent carrots but only 47 per cent leeks. Higher income classes eat more vegetables than lower, but women at work often cook as many vegetables as those with more leisure. Only the well-to-do use

methods advocated by the 'kitchen front' or taught in the schools. Age seems to make no difference. Food 'education' seems to have little effect.

Mrs. B. Callow (School of Biochemistry, Cambridge) referred to the recent publication, "Food Consumption Levels", and said that we in Great Britain apparently receive food which, before cooking, yields sufficient vitamin C. The U.S. National Research Council recommends 75 mgm. a day for men, and a restricted standard of 50 mgm. In Great Britain, we obtain at least 85 per cent of one vitamin C from vegetables in war-time, and cooking may result in lowering that 75 mgm. below safety-level.

Later speakers directed attention to the fact that the freshness of vegetables affects the vitamin C, though wilting affects spinach more than it does the Brassicas. The amount of ascorbic acid left in vegetables after boiling depends more on the final amount of the boiling water than on its volume to begin with. Sodium bicarbonate does not influence the loss during boiling, but alkalinity of the vegetable when dished up accelerates the rate of oxidation of ascorbic acid after the dishing up. Officials from the Ministry of Food find that vitamin C estimations in cooked food are often below those calculated from tables even though the method of preparation is thoroughly known, and are pessimistic about the use of tables for estimating individual intakes of vitamin C. Shredding vegetables does not markedly alter their vitamin C content. Miss M. Olliver gave an account of the laboratory assessment of nutritive value of meals which Dr. G. N. Jenkins, Dr. L. W. Mapson and she had carried out. If sampling is conscientious, and bulking and mixing of the samples is adequate, and precautions are taken to prevent oxidation of ascorbic acid, the results of estimations are not so very different from those found by calculations from tables; but Miss Olliver stressed that anyone using tables for calculating the ascorbic acid intake must have considerable experience of the methods used in cooking and serving vegetables. She also demonstrated an admirable American machine for mixing samples of foods.

Dr. C. P. Stewart (Royal Infirmary, Edinburgh) opened the discussion on this communication. He said that the agreement between calculation and observations on ascorbic acid in foods is not bad. A hospital he had investigated reduced the figure of ·8 mgm. per 100 gm. of potatoes down to 0·8 mgm. 'as served'.

Dr. Yudkin (R.A.F.) pointed out that the physiological state of members of an institution can be used to estimate the value of the diet given. After six months, the hæmoglobin figure for the W.A.A.F.s rose from 95 on the Haldane scale to 102. Dark adaptation is normal in the R.A.F. and W.A.A.F. The caloric value of the diet is more than 3,000 Calories a day, and though only 40 per cent of the protein in the diet is animal protein its biological value is that of milk protein.

The afternoon was devoted to the data obtained from analyses of institutional diets. Miss E. M. Langley (Board of Education) spoke of school meals. The Oslo meal is popular with children but takes long to eat and therefore is unpopular with the staff where quarters are cramped. 1,000 Calory-meals are not difficult to produce, but cooks are reluctant to use concentrated foods. The target is 3,000,000 meals a day. At the outbreak of the War, 250,000 were served. To-day, the figure is 1,500,000 despite cramped quarters, absence of kitchens and dining-rooms. There is no doubt that school meals and school milk improve health and physique, and this service is becoming an integral part of the educational system of Great Britain.

Dr. M. Pyke (Ministry of Food) gave an account of investigations of factory canteen meals and service, and showed that the effect of a small change of the shift-time alters the spacing, times and natures of meals taken by work-people enormously. The pattern of the meals, the size and quantity of the nutrients taken varies immensely with a minor shift in hours and by no means in a predictable manner. There is a big variation, too, in the energy value of the foods taken by different workers, but there is considerable correlation between it and their work. Between different parts of the country, even in the same industry, there are marked differences in tastes. The coal miners in Wales eat cheese, the Durham miners refuse it. Are traditional methods of feeding justified, and should we pay attention to prejudices?

Dr. A. Lyall (University of Aberdeen) reported on hospital diets in three different hospitals. It was found that food brought in by friends of patients varied from 200 to 800 calories per day. As 40 per cent of patients in one hospital were on a light diet and 32 per cent on special diets, this extra food represents a marked interference with the feeding of the patients. It is doubtful if it should be allowed.

Miss M. C. Broatch (King Edward's Hospital Fund), who has had much experience in the feeding of school children, maintained that the Oslo type of meal should be preferred. The children have to sit longer to masticate it and get a rest during dinner-time. But often children are hurried through meals because, owing to inadequate accommodation, there have to be two sittings in the dinner hour. She said that no survey yet showed meals giving 1,000 Calories, and so children cannot be getting what the Ministry of Food recommends. Serving raw vegetables in the Oslo meal makes the 1,000-Calorie meal still more unlikely. Only by giving suet puddings can the 1,000-Calorie meal be attained.

Meals are best in institutions where there is a buyer, and food is not bought on contract. To serve dietetic meals in hospitals needs a reorganization of staff, for generally the cook is untrained, the steward has no experience and the housekeeping sister has had no training in general catering. All caterers ought to be cooks. Food should not be brought in by friends. The proper feeding of patients in hospitals is part of the treatment. A very weak spot is the delay between kitchen and ward and ward and patient. Meals in transit lose much of their value.

A Cardiff worker reported that school meals sometimes reach Miss Langley's figure. But the average for vitamin C in a large number of canteens throughout a year was 25 mgm. ascorbic acid a meal. It is almost impossible to get higher figures with the expenditure allowed and the equipment available. Children cannot, or will not, eat enough watercress to give 25 mgm. ascorbic acid—they take 8–10 gm. a meal instead of about 100 gm. One third of the children get no vitamin C at any other meal.

Dr. Magee (Ministry of Health) pointed out that Dr. Milligan of Glossop was using the 'Oslo' meal years before we ever heard of it in Britain. He questioned if there is much deficiency disease among children in Great Britain. When 5,000 children were investigated, no single case of scurvy was discovered; but riboflavin deficiency is sometimes observed. One reason for the poor diet in hospitals is that caterers

do not know the priorities they are entitled to. They should be able to serve 131 gm. protein a day, of which 78 gm. could be animal protein. Hospitals often underdraw their rations of meat, dried eggs and milk.

The general impression produced by all the discussions was that though an enormous amount is known about the way people should be fed, there are not the trained personnel, equipment, or space to do the work adequately.

The Society passed a resolution, moved by Sir Joseph Barcroft, recommending that the Committee of the Society investigate the possibility of carrying out direct calorimetry experiments.

## OBITUARIES

### Mr. W. L. Sclater

WILLIAM LUTLEY SCLATER was born on September 23, 1863, and died through enemy action in June. He was the eldest son of Dr. P. L. Sclater and was educated at Winchester, and afterwards at Keble College, Oxford, where he studied under Moseley and Hickson, taking his M.A. with first-class honours in natural science in 1885. In the following year he worked under Ray Lankester in London, and also made a short collecting trip to British Guiana, whence he brought back live specimens of Peripatus.

In 1887 he acted as demonstrator to Sedgwick at Cambridge, and in August was appointed deputy superintendent in the Indian Museum at Calcutta. There he remained until 1891 and, in addition to other work, prepared Part 2 of the "Catalogue of Mammalia in the Museum", also lists of the birds' eggs, snakes and Batrachia. Towards the end of 1891 Sclater returned to England and joined the staff of Eton College as one of the science masters. In the latter part of 1895 he was appointed director of the South African Museum at Cape Town; but before proceeding there he married on February 1 Charlotte Seymour, daughter of W. P. Mellen of Colorado Springs. A new wing had just been completed for the South African Museum, and Sclater removed and rearranged the collections and also reorganized the staff. He widened the scope of the Museum and started the *Annals of the South African Museum*. The planning and publication of the "Fauna of South Africa" was principally due to Sclater, who acted as editor and wrote the two volumes on mammals. He was responsible for Vols. 3 and 4 of the birds after Dr. Stark's death in Ladysmith. This work, although now out of date, is still of value to the student of the South African fauna.

In 1906 Sclater and his wife returned to England via Mombasa, Victoria Nyanza, Khartoum and Cairo, which was quite an undertaking in those days. Shortly after his return Sclater was invited by his wife's uncle, General W. J. Palmer, to develop and enlarge the museum recently established in connexion with Colorado College. After General Palmer died in 1909 Sclater gave up his post and returned to London, where he took up residence at 10 Sloane Court, and began his long connexion with the Bird Room of the British Museum. Besides continuing his studies on African birds and publishing important papers he became the recorder for the section of Aves of the *Zoological Record*. This he continued to the time of his death, and at different times was responsible for other sections, including Mammalia and Crustacea. From 1921 until 1937 he was general editor and introduced many important changes into the arrangement of the *Record*. In 1912 he published a "History of the Birds of Colorado".

After the retirement of Mr. Ogilvie Grant in 1918, Sclater was entrusted with the temporary care of the ornithological collections in the British Museum up to the appointment of Dr. P. R. Lowe in 1919. During that time he rearranged part of the collection and prepared a manuscript "Catalogue of the Birds of Prey".

The Sclaters travelled much on the Continent and in North Africa and in 1919 made a trip round the world, including visits to many of the principal museums in the United States, where they renewed many old friendships. On their return Sclater commenced his great work, the "Systema Avium Æthiopicarum", which was published in 1924. This book is indispensable to all students of African birds. He also edited from Sir Frederick Jackson's manuscript "The Birds of Kenya Colony and Uganda Protectorate" (1938).

Sclater succeeded his father as editor of the *Ibis* in 1913, and for seventeen years held that office. He was president of the British Ornithologists' Union from 1928 until 1933, and in 1930 was presented with the Salvin-Godman Gold Medal for his services to ornithology.

In addition to birds Sclater had many other interests, including family history, publishing in 1922 a delightful volume of an ancestress Eliza Draper, better known as 'Strene's Eliza'. At the time of his death he was honorary secretary of the Royal Geographical Society and had held that office since 1931. Owing to his long connexion with the *Zoological Record*, Sclater had a very wide knowledge of literature, which he readily placed at the disposal of others. This knowledge was not confined to modern works, for he was a recognized authority on the older writers. He was a great walker, and few knew the country around London better than he.

His death is a great loss to his many friends, and in the Museum we will miss seeing that tall, slightly stooping figure walking through the galleries on his way to and from the Bird Room.

N. B. KINNEAR.

### Dr. I. Markovič

IT has recently been learned that Dr. Ivan Markovič, a former Czechoslovak Minister of Education and sometime editor of the Bratislava literary and scientific periodical, *Prudy*, died in a German concentration camp some months ago. Markovič was born at Myjava in Slovakia in 1888 and was in Russia at the outbreak of the War of 1914–18. He eventually became a member of the Czechoslovak National Council and held various diplomatic and Government posts after the formation of the Czechoslovak Republic in 1918.

WE regret to announce the following deaths:

Prof. Carl Jakobj, emeritus professor of pharmacology at Tübingen, aged eighty-seven.

Dr. L. E. Shore, O.B.E., formerly lecturer in physiology and junior bursar of St. John's College, Cambridge, on July 27, aged eighty-one.

Dr. J. N. Sugden, senior lecturer in inorganic chemistry at the Imperial College of Science and Technology, in July, by enemy action.

# NEWS and VIEWS

## Swedish Anthropological and Geographical Society: Award to Prof. L. von Post

THE highest distinction of the Swedish Anthropological and Geographical Society, the Vega Medal, has just been awarded to Prof. Lennart von Post, of Stockholm, for his outstanding contributions to the development and application of the methods of pollen analysis. It is Prof. von Post above all others who, by his clear vision and indomitable energy, both perfected and popularized the systematic analysis of the sub-fossil pollen content of lake- and peat-deposits. Speaking at the meeting when the award was made, Prof. von Post emphasized the manner in which pollen analysis studies from all parts of the world—Tierra del Fuego, New Zealand, North America, North China, as well as Europe—showed a similar post-glacial climatic drift, first of increasing temperatures, then through a period of severe heat and drought, and finally a recession to the climate of to-day. He visualized a forthcoming phase of international co-operation in pollen analysis work in systematically selected areas all over the world, by means of which we should resolve the general pattern of the cyclic climatic history of the world in the period since the last ice age. May Prof. von Post's vision be again rewarded by scientific advances comparable with those he has already accomplished.

PROF. LENNART VON POST (LEFT) RECEIVING THE VEGA MEDAL OF THE SWEDISH ANTHROPOLOGICAL AND GEOGRAPHICAL SOCIETY FROM THE CROWN PRINCE OF SWEDEN.

## Co-operative Research in Industry

IN reply to a question from Lord Barnby in the House of Lords on August 1, Lord Templemore re-affirmed the great importance attached by the Government to co-operative research as a means of developing to the full the use of the industrial resources of Great Britain, a vigorous export trade and a higher standard of living. While the Cotton Industry Research Association, which receives a substantial contribution from the Cotton Board, set up under the Cotton Industry Act, is the only research association which is not supported solely by voluntary contributions or voluntary levies, apart from the Government grant, recently several industries, including the wool industry, have expressed themselves in favour of statutory powers of one sort or another, including the collection of money for research by means of a levy on the whole industry, and research associations are now much more inclined to welcome an enabling bill. Lord Templemore said he was authorized to state that the Government will be prepared to consider sympathetically the introduction of enabling legislation for this purpose, if there is sufficient demand for it from industry, and that the matter will be discussed with industry in the coming months in connexion with post-war plans. The Government would also wish to be satisfied whether there are other proper objects connected with the furtherance of the export trade or of industry's efficiency generally for which a statutory power to collect money might be desirable.

## Human Factors in Industrial Output

IT is sometimes forgotten that output results from human activity and that therefore the amount will be dependent on many factors, of which it has been shown that the number of hours worked each week is one. There is abundant evidence that excessive hours result in diminished output. When, however, hours are relatively reasonable, can it be argued that a further reduction will increase the output ? A recent report ("A Study of Variations in Output." By S. Wyatt and others. Emergency Report No. 5 of the Industrial Health Research Board. (London: H.M. Stationery Office, 1944.) 4*d*. net.) analyses some of the factors which had measurable effects on output. Study of the output records of a number of factories showed a striking variability. Some of the chief causes were: (*a*) changes in the type or design of the product; (*b*) mechanical difficulties and machine breakdown; (*c*) variations in the quantity and quality of the materials used; (*d*) progressive improvements in the methods or conditions of work; (*e*) changes in the type and lay-out of machines; (*f*) personal factors such as dissatisfaction with the methods or rate of payment, and occasional friction between the management and the workers.

The effects of the shorter hours of work were in most groups obscured by one or other of the above factors; but, when these were absent, reduction of hours from about an average of 60 to 55 a week for men, with a corresponding decrease for women, had a favourable result on the output. Absenteeism also tended to decrease as the weekly hours of work decreased. The results suggest that there is need for more research work to determine under what general or specific conditions changes of design, for example, have unfavourable effects on output, and the relative effectiveness of the chief causes of variations in output. Machines should be made for men, not men forcibly adapted to machines, which means careful physiological and psychological study.

## Research and Development in Scotland

A MEMORANDUM, "Chemical Research and Development in Scotland", by R. H. S. Robertson issued as *Bull.* No. 3 (March 1944) by the Scottish Reconstruction Committee urges the need for chemical and physical research and development in Scotland, stressing particularly housing research and research in relation to hydro-electricity, the lack of trained personnel in Scotland and the inadequacy of present facilities. The memorandum suggests the formation of a Scottish raw materials department under the Department of Scientific and Industrial Research,

with a wider field of activities than a development branch of the Geological Survey which would be restricted to the study of minerals, including peat. This department should co-ordinate every stage of development from survey to production and carry out the experimental work which existing organizations are not equipped to do, as well as serve as an institution for giving additional training to the technical men who will develop and eventually run the new industries. Apart from its references to seaweed and peat, the memorandum gives very little indication of what materials call for the creation of a new department to investigate Scottish resources. Neglect of those resources will be readily admitted, but it is not clear from this memorandum why their investigation and development could not be undertaken as part of the general national research effort—why, for example, separate Scottish research into housing is required.

## Astronomy and the Struve Family

On the occasion of the award of the 1944 Gold Medal of the Royal Astronomical Society to Prof. Otto Struve, the president of the Society, Prof. E. A. Milne, reviewed the astronomical work of the Struves, which has been recognized by four awards of the Gold Medal to the family in 118 years—once in each generation (*Mon. Not. Roy. Astr. Soc.*, **104**, 112; 1944). Wilhelm Struve, founder of the Pulkovo Observatory, received the Gold Medal in 1826 for his work in discovering and measuring double stars. His son, an earlier Otto Struve, was awarded it in 1850 for a paper on "The Determination of the Constant of Precession with respect to the Proper Motion of the Solar System". The third medallist was Hermann Struve, uncle of the present holder, who gained the award in 1903 for his monumental work on the satellites of Saturn. This year's award goes to Prof. Otto Struve, director of the Yerkes and McDonald Observatories, and great-grandson of Wilhelm, for his observation and interpretation of the spectra of stars and nebulæ. Prof. Milne reviewed this work in some detail, and pointed out that the present medallist has followed the family tradition in founding a new observatory, and has exceeded it in directing not merely one but simultaneously two great observatories. In his power of execution of new projects, in the width and generality of the problems he has selected and attacked, and in the brilliance of his solution of these problems, said Prof. Milne, Otto Struve has worthily carried the family fame in a new branch of astronomy to a new continent, and made good.

## Telepathy in Psychoanalysis

Dr. H. J. Ehrenwald, formerly of Prague, has directed attention to the possibility of telepathy in the psychoanalytic situation (*Brit. J. Med. Psych.*, **20**, Pt. 1; 1944). It is well known to psychical researchers that since Freud mentioned this factor in his new series of introductory lectures, his pupils have obediently followed him and are themselves now at pains to discuss the question in relation to their own patients. In this paper, Dr. Ehrenwald extends these observations not only regarding telepathy from patient to analyst but also from analyst to patient. He mentions some of Freud's own cases, including the famous case of his patient, Mr. P., which Freud thought to be very suggestive, but which few psychical researchers would regard as worthy of serious consideration. What is, however, of more interest in Dr. Ehrenwald's paper is his obvious anxiety to warn his colleagues of the possibility of telepathy occurring during sittings with their patients, and the implications which can be derived from it. From the point of view of the psychical researcher this attitude is somewhat diverting, since for so many years psychoanalysts have declined to learn what parapsychologists could have taught them and now, having become almost convinced through Freud's influence that telepathy exists, present examples of it which exhibit so many sources of error that it is clear that they still have little appreciation of the problems on which they write. If Dr. Ehrenwald's paper disturbs still further their complacency, it will have performed a useful service.

## Chinese Journal of Agricultural Science

The British Council made a very happy choice in selecting Dr. J. Needham for its scientific mission in China. He has been indefatigable in promoting scientific work in that part of the country which remains in Chinese hands and in his efforts to keep British scientific workers informed about Chinese work. Since the outbreak of the War, most of the scientific journals in China have been discontinued, and in consequence those keen spirits that still go on with their scientific studies have their difficulties increased by the lack of any means of publication. A new journal has now been started by the Ministry of Agriculture and Forestry at Chungking, and the first issue is to hand. Among other papers are two on inheritance in wheat. One on dwarfness deals with the complex ratios obtained in counts of the $F_2$ progenies of the varietal crosses made in 1939; seven factors are assigned, of which three are complementary, three are duplicates of these and one is an inhibitor; the combinations necessary for dwarfness are discussed. The other paper is a mathematical discussion of Japanese data on the pentaploid hybrids of wheat. Trials are recorded of the Winogradksy Azotobacter plaque method for estimating potash and phosphate deficiencies in soils: this was found to be rapid and easily worked and seems likely to prove very valuable if its indications are borne out in practice. Other papers deal with the extraction of nicotine from tobacco leaves; the orange maggot (Tetradacus sp.); and a possible vermicidal plant, *Tripterygium wilfordii*. The papers are in Chinese, but with summaries in English. We wish the new journal all success.

## University of London

Mr. T. H. Marshall has been appointed as from October 1 to the University chair of social institutions tenable at the London School of Economics. Since the beginning of the War he has worked in the Foreign Office Research Department, as head of the German Section since the autumn of 1940, and as deputy director since the spring of 1943.

Mrs. Barbara Wootton has been appointed as from October 1 to the University readership in social studies tenable at Bedford College. Since 1927 she has been director of studies for tutorial classes in the University and has acted as visiting lecturer in the Department of Social Studies at Bedford College for some years.

The title of professor of chemistry in the University has been conferred on Dr. E. E. Turner, in respect of the post held by him at Bedford College.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Liver Ribonucleic Acid

IT has previously been shown[1] that mammalian tissues contain, in addition to nuclear desoxyribonucleic acid (thymonucleic acid), appreciable amounts of pentose nucleic acid, which appears to be mainly a cytoplasmic constituent[2]. Liver tissue, for example, is known to contain both a desoxyribonucleic acid similar to the thymus nucleic acid[3] and a pentose nucleic acid[1]. The latter has now been isolated from the liver tissue of the sheep. The finely minced liver is dehydrated with ethanol and the nucleic acids extracted with 10 per cent sodium chloride. They are precipitated with ethanol, and the barium salts fractionated by the method used by Jorpes[4] for the pentose nucleic acid of the pancreas. The pentose nucleic acid is finally purified by precipitation from glacial acetic acid. The material so obtained is free from protein and from desoxyribonucleic acid. It is similar to yeast ribonucleic acid in its pentose content and in its absorption spectrum. Its contents of purine and easily hydrolysable phosphorus are consistent with a tetranucleotide structure with equimolecular amounts of purine and pyrimidine. It appears to differ, therefore, from the pentose nucleic acid of the pancreas, for which a pentanucleotide structure has been suggested[4].

From the hydrolysis products obtained by the method of Bredereck and Richter[5], we have prepared the pentose and identified it as ribose by the *p*-bromophenylhydrazone, which melted at 168–169°. This melting point showed no depression when the derivative was mixed with a sample of the *p*-bromophenylhydrazone prepared from pure *d*-ribose. The nucleic acid can therefore be correctly designated 'liver ribonucleic acid'. Gulland and Barker[6] have recently proved conclusively that the pentose of yeast ribonucleic acid is *d*-ribose, and have shown that small amounts of *l*-lyxose are also present. The amounts of liver ribonucleic acid so far available have been too small to enable tests for lyxose to be made.

Liver ribonucleic acid acts as a substrate for crystalline ribonuclease. When sections of liver tissue, fixed, embedded and mounted, are stained with toluidine blue, both nuclei and cytoplasm take up the stain. If the sections are treated with ribonuclease in the manner employed with other tissues[7], and then with toluidine blue, the nuclei alone stain. The liver ribonucleic acid, therefore, probably occurs in the cytoplasm, in which it may be present in the form of phospholipin-ribonucleoprotein complexes in the particulate components (mitochondria[8], secretory granules[9], microsomes[10]). These complexes are known to contain a nucleic acid of the pentose type which is presumably identical with the ribonucleic acid which we have isolated.

In confirmation of the work of others[11], we have found that the total nucleic acid concentration in the liver of the rat rises on fasting, although the liver weight relative to the body weight falls. Dry powders of rat livers from which acid-soluble and lipoid phosphorus had been removed, contained $554 \pm 10{\cdot}7$ mgm. residual phosphorus per 100 gm. in the case of fed animals and $583 \pm 20{\cdot}5$ mgm. in the case of fasted animals. Of this residual phosphorus, $75{\cdot}3 \pm 2{\cdot}33$ per cent in the fed animals and $66{\cdot}0 \pm 2{\cdot}86$ per cent in the fasted animals was accounted for as ribonucleic acid phosphorus; $17{\cdot}6 \pm 0{\cdot}59$ per cent in the fed animals and $20{\cdot}2 \pm 0{\cdot}84$ per cent in the fasted animals was accounted for as desoxyribonucleic acid phosphorus. The fall in ribonucleic acid and the rise in desoxyribonucleic acid on fasting were both statistically significant. These results would be consistent with the disappearance from the cytoplasm of particulates containing ribonucleic acid, and with the loss in phospholipin and in nucleoprotein observed in the livers of rats fasted or placed on a protein-poor diet[12].

J. N. DAVIDSON.
C. WAYMOUTH.

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July 4.

[1] Davidson, J. N., and Waymouth, C., *Biochem. J.*, **38**, 39 (1944).
[2] Mirsky, A. E., "Advances in Enzymology", **3**, 1 (1943). Pollister, A. W., and Mirsky, A. E., *Nature*, **153**, 711 (1944).
[3] Greenstein, J. P., and Jenrette, W. V., *J. Nat. Cancer Inst.*, **1**, 91 (1940). Dounce, A. L., *J. Biol. Chem.*, **147**, 685 (1943).
[4] Jorpes, E., *Biochem. J.*, **28**, 2102 (1934).
[5] Bredereck, H., and Richter, C., *Ber. Deut. Chem. Ges.*, **71** (B), 718 (1938).
[6] Gulland, J. M., and Barker, G. R., *J. Chem. Soc.*, 625 (1943).
[7] Brachet, J., *C.R. Soc. Biol.*, **133**, 88, 90 (1940); *Arch. Biol.*, **51**, 151, 167 (1940). Gersh, I., and Bodian, D., *Biol. Symp.*, **10**, 163 (1943).
[8] Bensley, R. R., *Science*, **96**, 389 (1942). Hoerr, N. L., *Biol. Symp.*, **10**, 185 (1943).
[9] Claude, A., *Cold Spring Harbor Symp. Quant. Biol.*, **9**, 263 (1941).
[10] Claude, A., *Science*, **97**, 451 (1943).
[11] Kosterlitz, H. W., and Cramb, I. D., *J. Physiol.*, **102**, 18P (1943)
[12] Kosterlitz, H. W., *Nature* (see following communication).

## Effect of Dietary Protein on Liver Cytoplasm

IT is well known that the protein content of the liver can be lowered by fasting or by feeding a low-protein diet and raised by feeding a high-protein diet. The question arises: Is the protein stored in the liver as is glycogen, or is it built into the structure of the cytoplasm? Since the evidence so far available on this point is equivocal, it was decided to correlate, under various nutritional conditions, the protein content of the liver with other cytoplasmic constituents, namely, phospholipin and nucleic acid.

In a previous communication[1] it was shown that fasting caused a loss in the protein as well as the phospholipin and nucleic acid contents of the livers of rats. Similar changes are obtained if the animals are placed either on a protein-free diet or given protein deficient in one or more essential amino-acids. On the other hand, a high protein diet causes an increase in the protein, phospholipin and nucleic acid contents of the liver. There is no change in the number of liver cell nuclei (Table 1).

If the protein content of the diet is varied, the relative concentrations of protein and phospholipin remain remarkably constant, while that of nucleic acid rises gradually with falling protein intake (Table 2). This latter fact is probably due to there being no, or only little, loss in nuclear material which, although in mass much smaller than cytoplasm, has a much higher concentration of nucleic acid than cytoplasm. This interpretation is supported by the recent findings[2] that the ratio of ribonucleic to desoxyribonucleic acid is lower in livers of fasted rats than in those of fed rats. The relative

TABLE 1.

| Diet* | Liver Protein | Liver Phospholipin | Liver Nucleic acid | Liver nuclei per 100 × $10^{-6}$ gm. body weight |
|---|---|---|---|---|
| | mgm./100 gm. mean body weight | | | |
| Stock | 607 | 118 | 46 | 599 |
| 20 per cent casein + 8 per cent yeast | 621 | 114 | 49 | 590 |
| 8 per cent yeast | 454 | 82 | 41 | 556 |
| 18 per cent gelatin + 8 per cent yeast | 495 | 96 | 44 | 544 |
| 60 per cent casein | 701 | 120 | 51·5 | 546 |
| 85 per cent casein | 770 | 124 | 55 | 603 |

* Female hooded rats 4 months old were given 16 gm. of the diets daily for one week. The diets contained 2 per cent agar, 3 per cent salts, 10 per cent lard, 25 per cent sucrose and varying quantities of protein and starch. Vitamins A, D and E were given in the usual manner, and the vitamin B complex in the form of dried yeast or of a mixture of aneurin, riboflavin, pyridoxin, calcium pantothenate, nicotinic acid, inositol and choline chloride, supplemented by liver concentrate.

protein concentration shows a slight rise when the protein intake is above optimum requirements.

The constituents of liver cytoplasm which contain protein, phospholipin and nucleic acid are the chromophilic substance of the cytoplasm and the mitochondria[2]. A recalculation of Claude's results on rats' livers yields as approximate composition of the chromophilic substance (on a dry glyceride-free basis) 60 per cent protein, 33 per cent phospholipin and 7 per cent nucleic acid; and of the mitochondria 74 per cent protein, 15 per cent phospholipin and 8 per cent nucleic acid. The nucleic acid is ribonucleic acid[2,3]. The nuclei contain 22 per cent desoxyribonucleic acid[4]. Since the phospholipin content of the whole liver cell is considerably lower than that of the chromophilic particulates, it would appear that not only the relative concentration of the chromophilic lipoprotein–nucleic acid complex but also that of the interparticulate protein, which is almost free from phospholipin[2], remain constant. In other words, the changes in the protein contents of the livers observed after fasting and diets low or high in protein are due to changes in the cytoplasm content of the liver. This phenomenon is of greater physiological and pathological significance than would be a simple storage of protein, in that many of the enzymatic activities of the liver cell are associated

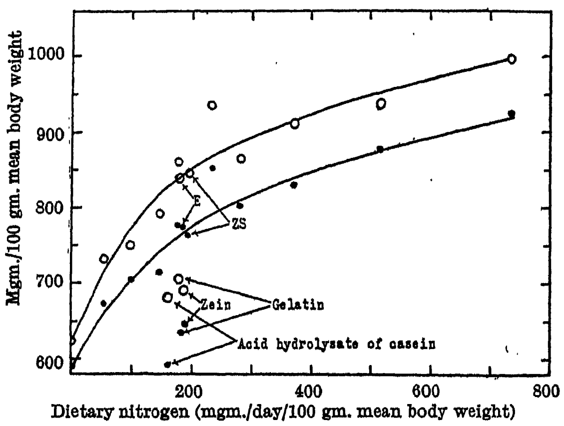
TABLE 2.

| Diet | Protein + phospholipin + nucleic acid mgm./100 gm. mean body weight | Protein | Phospholipin | Nucleic acid |
|---|---|---|---|---|
| | | per cent | | |
| Stock | 771 | 78·8 | 15·2 | 5·95 |
| Protein-free | 583 | 77·8 | 15·3 | 6·85 |
| 5 per cent casein | 672 | 78·5 | 14·9 | 6·6 |
| 10 ,, ,, ,, | 705 | 78·6 | 15·0 | 6·3 |
| 15 ,, ,, ,, | 714 | 78·7 | 14·8 | 6·5 |
| 20 ,, ,, ,, | 776 | 78·7 | 14·9 | 6·3 |
| 25 ,, ,, ,, | 852 | 79·5 | 14·6 | 6·1 |
| 30 ,, ,, ,, | 801 | 80·0 | 13·9 | 6·05 |
| 40 ,, ,, ,, | 830 | 80·4 | 13·7 | 5·85 |
| 60 ,, ,, ,, | 877 | 80·6 | 13·7 | 5·8 |
| 85 ,, ,, ,, | 923 | 80·6 | 13·4 | 5·9 |
| 24 hr. fast | 638 | 78·1 | 15·5 | 6·35 |
| 48 ,, ,, | 586 | 78·1 | 15·2 | 6·6 |
| 24 ,, ,, after protein-free diet | 612 | 77·9 | 14·9 | 7·2 |

with its cytoplasmic particulates[2]. It has also been found that the arginase activity of the liver is dependent on the quantity of dietary protein[5]. These facts are of importance in view of the damaging effects which low-protein diets have on liver function[6].

Rats on a protein-free diet lose 15 per cent of their initial liver cytoplasm on the first day, 7 per cent on the second day, 5 per cent during the period from the second to the seventh day, and another 5 per cent during the second week. It appears that about 20–25 per cent of the liver cytoplasm of animals fed sufficient quantities of protein is very easily and rapidly lost, and it is suggested this fraction be called 'labile liver cytoplasm'. This term, however, is not meant to indicate a chemical distinction between the labile and the remaining cytoplasm.

The histological diagnosis of the loss of cytoplasm is complicated by the fact that the total weight of the liver may undergo considerable changes and is, at least so far, only possible in livers which have lost considerable quantities of their cytoplasm, namely, 20–25 per cent. However, the livers of the rats given the low protein diets remain almost constant in weight and show a diminution of their stainable cytoplasm and mitochondria. An apparent




EFFECT OF VARYING THE DIETARY PROTEIN ON THE CYTOPLASM CONTENT OF THE LIVER.

○—○, Non-glycogen non-lipin solids. ●—● Protein + phospholipin + nucleic acid. The dietary protein was casein except where specially marked, thus: *E*=diet containing 21·5 per cent egg albumin; gelatin=diet containing 18 per cent gelatin + 8 per cent yeast; zein=diet containing 18·5 per cent zein; *ZS*=diet containing 18·5 per cent zein supplemented with 2 per cent *l*-tryptophane and 5 per cent *l*(+) lysine dihydrochloride; acid hydrolysate of casein=diet containing 22·4 per cent acid hydrolysate of casein, deficient in tryptophane.

vacuolization takes place, probably due to the largely increased glycogen content of these livers. In fasted animals, due to a decrease in liver weight, there is chemically an increase in the concentration of cytoplasmic substance although the absolute quantity of cytoplasmic substance decreases. Histologically, small cells are found which stain intensely. These findings are in good agreement with those reported by Elman, Smith and Sachar[7].

The changes in cytoplasmic substance may also be determined, with a high degree of approximation, by estimating the non-glycogen non-lipin solids. This method may lend itself to a rapid assessment of the biological values of proteins (see accompanying graph).

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[1] Kosterlitz, H. W., and Cramb, I. D., *J. Physiol.*, **102**, 18P (1943).

[2] Bensley, R. R., *Science*, **96**, 389 (1942). Claude, A., *Biol. Symp.*, **10**, 111 (1943). Hoerr, N., *Biol. Symp.*, **10**, 185 (1943). Lazarow, A., *Biol. Symp.*, **10**, 9 (1943).

[3] Davidson, J. N., and Waymouth, C., *Nature*, **152**, 47 (1943); *Nature* (see preceding communication).

[4] Dounce, A. L., *J. Biol. Chem.*, **151**, 221 (1943).

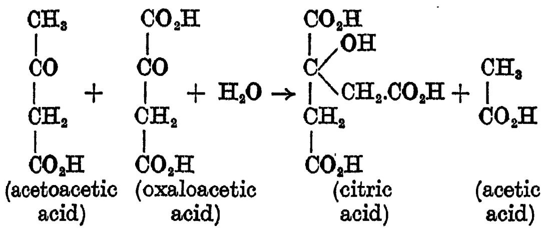
[5] Lightbody, H. D., and Kleinmann, A., *J. Biol. Chem.*, **129**, 71 (1939).

[6] Miller, E. L., and Whipple, G. H., *Amer. J. Med. Sci.*, **199**, 204 (1940). Elman, R., and Heifetz, C. J., *J. Exp. Med.*, **73**, 417 (1941). Himsworth, H. P., and Glynn, L. E., *Lancet*, i, 457 (1944).

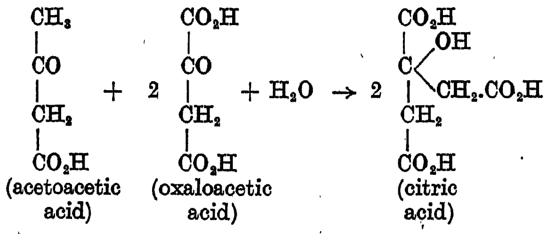
[7] Elman, R., Smith, M. G., and Sachar, L. A., *Gastroenterology*, **1**, 24 (1943).

## Metabolism of Acetoacetic Acid in Animal Tissues

BREUSCH[1] assumes that acetoacetic and oxaloacetic acids form citric acid in animal tissues according to the reaction:



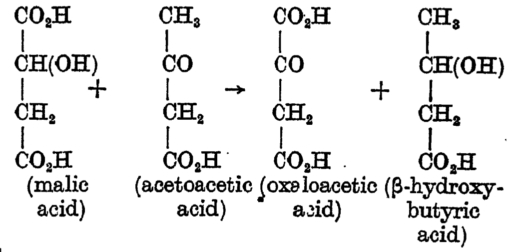

Wieland and Rosenthal[2], apparently independently, arrive at a similar view. They suggest that the following reaction occurs in kidney and heart:



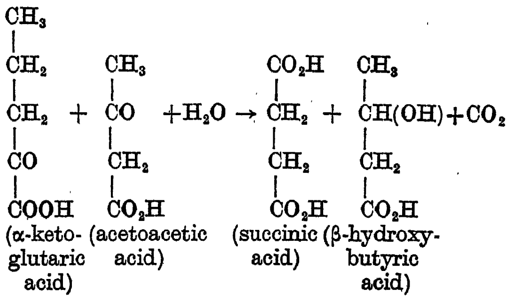

Both schemes are based on the observation that under certain conditions more citric acid is obtained from oxaloacetic and acetoacetic acids together than from oxaloacetic or acetoacetic acid alone. The importance of the schemes lies in the fact that they outline for the first time a mode of breakdown of acetoacetic acid in animal tissues, a problem which, in spite of many efforts, previous workers have failed to unravel.

Experiments on sheep heart and sheep kidney, although they confirm the observation that acetoacetic acid can increase the yields of citric acid (or its breakdown products) in the presence of oxaloacetic acid, are incompatible with the above schemes. In both tissues the removal of acetoacetic acid is much accelerated by oxaloacetic acid (or its precursors). The effect is greater under anaerobic than under aerobic conditions. A detailed examination of the products of the anaerobic interaction between acetoacetic and oxaloacetic acids—involving the quantitative determination of acetoacetic, oxaloacetic, β-hydroxybutyric, citric, *iso*citric, *cis*-aconitic, α-ketoglutaric, α-hydroxyglutyric, succinic, fumaric, malic, pyruvic and lactic acids—showed that the extra acetoacetic acid removed by interaction with oxaloacetic acid can be quantitatively recovered as β-hydroxybutyric acid.

The formation of β-hydroxybutyric acid is not due to a direct interaction between acetoacetic and oxaloacetic acids. Two substances arising in tissues from oxaloacetic acid—malic acid and α-ketoglutaric acid—were found to react with acetoacetic acid. The two reactions are:

(1) 


and

(2) 


Reaction (2) has already been observed in other tissues by Krebs and Johnson[3] (1937).

Oxaloacetic acid, when added anaerobically to tissues, is in part reduced to malic acid[4]. The portion undergoing reduction varies, according to conditions, between 25 and 70 per cent. The remaining fraction enters oxidative conditions, the chief products of oxidation being, apart from carbon dioxide, citric acid (together with *iso*citric acid, *cis*-aconitic acid) and α-ketoglutaric acid. For example[4]:

(3) 3 oxaloacetic acid → malic acid + tricarboxylic acid* + $2CO_2$

or

(4) 4 oxaloacetic acid → 2 malic acid + α-ketoglutaric acid + $3CO_2$.

When reaction (1) is superimposed on (3) or (4) oxaloacetic acid is regenerated from malic acid and the reformed oxaloacetic acid will react again according to (3) or (4). The overall effect of (1) and (3) is

(5) 2 oxaloacetic acid + acetoacetic acid → tricarboxylic acid + $2CO_2$ + β-hydroxybutyric acid;

and of (1) and (4)

(6) 2 oxaloacetic acid + 2 acetoacetic acid → α-ketoglutaric acid + $3CO_2$ + 2 β-hydroxybutyric acid.

If (2) is superimposed on (6) the overall effect is

(7) 2 oxaloacetic acid + 3 acetoacetic acid + $H_2O$ → succinic acid + $4CO_2$ + 3 β-hydroxybutyric acid.

In our experiments the increased yields of citric, α-ketoglutaric and succinic acids were fully accounted for by the above schemes.

A study of the reactions of acetoacetic acid in the

* 'Tricarboxylic acid' stands for the mixture of citric, *iso*citric and *cis*-aconitic acids, 'malic acid' for the mixture of malic and fumaric acids.

presence of oxygen does not indicate that there are other reactions between oxaloacetic and acetoacetic acids besides (1) and (2) in sheep heart muscle. Under the conditions of our experiments oxaloacetic acid had no effect on the *oxidative* breakdown of acetoacetic acid. The intermediate stages of this process must still be regarded as obscure.

Experimental details are to be published in the *Biochemical Journal*.

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[1] Breusch, F. L., *Science*, 97, 480 (1943).
[2] Wieland, H., and Rosenthal, C., *Liebigs Ann.*, 554, 241 (1943).
[3] Krebs, H. A., and Johnson, W. A., *Biochem. J.*, 31, 241 (1937).
[4] Krebs, H. A., Eggleston, L. V., Kleinzeller, A., and Smyth, H. D., *Biochem. J.*, 34, 1234 (1940).

## Substitution of Whole Stomach Extract for Vitamins in the Treatment of Malignant Infantile Pellagra

DURING the last three years, close on three hundred children suffering from acute malnutrition have been admitted to the non-European Hospital, Johannesburg. More than 60 per cent of these infants manifested the clinical signs of infantile pellagra. The dominating features of this disease were œdema affecting upper and lower extremities, and in severe cases the face, eyelids and genitalia; this œdema was associated with pellagrous skin lesions on the legs, buttocks, back, arms and face, grey hair or alopecia, as well as patchy or diffuse dermal depigmentation. The stools were, as a rule, bulky, pale and foul-smelling, and contained much unsplit fat. The serum proteins, both albumen and globulin, were extremely low, a mild microcytic anæmia was common, and the liver, on biopsy and at post-mortem, was diffusely fatty. This severe form of malnutrition is apparently identical with that described by other investigators[1,2,3,4].

Trowell[5], an outstanding worker in this field, has repeatedly recorded the unresponsiveness of this disease to vitamin therapy, including nicotinic acid, and recorded a 90 per cent death-rate. For this reason he decided to discard the name 'infantile pellagra', and to call it 'malignant malnutrition'.

In our experience, not only has vitamin therapy failed to save the lives of more than 50 per cent of these children, but also in many instances we strongly suspected that vitamin therapy aggravated the disease and even hastened death. This opinion is substantiated by the sudden increase in œdema, as well as of fatty change in the liver, when vitamins were administered. Blood and serum transfusions also proved valueless. In these circumstances it was essential to seek some other method of saving the lives of these children.

We established, by an improved liver biopsy procedure, that the microscopic appearance of the liver is a most valuable method of assessing the severity of the condition and is certainly more reliable than the clinical picture or any of the laboratory findings. We therefore adopted the liver biopsy method as a routine procedure in gauging the condition of the child on admission and the effectiveness of our therapy. Twenty children were studied by this method. Of these, seven were treated with thiamin, nicotinic acid or brewers' yeast administered either orally or parenterally; seven were given 5 c.c. of Abbott's crude liver extract intramuscularly twice daily for seven days, and the final group of six cases were treated with 10 gm. of ventriculin (Parke Davis) plus 10 c.c. of $N/10$ hydrochloric acid daily, in one dose, for five days.

All these cases had extremely fatty livers which, from our previous observations, indicated a very poor prognosis. Progress was assessed by the clinical condition, the weight curves (as an index of the gain or loss of œdema fluid) and weekly liver biopsies.

Only one child of the seven treated with vitamins survived. The œdema increased progressively, the fat in the liver became more extensive, the children became more apathetic and died within two weeks. Five of the seven children treated with liver extract lived. The recovery was slow, the œdema subsiding gradually. Even after four weeks the liver still contained appreciable amounts of fat.

The response to ventriculin therapy was most dramatic, since all the children survived, despite the fact that clinically and by liver biopsy they were as bad as the cases in the other two groups. A loss of œdema fluid shown by the decrease of 1–1½ lb. in weight was usually observed within twenty-four hours. Moreover, the clinical condition improved in a remarkable fashion, and the liver was almost free of fat within two weeks.

Whole extracts of hog's stomach has occasionally been used for the treatment of pellagra in adults with good results[6,7,8]. In seven cases of severe pellagra in adults we have found that, except for the mental symptoms, which respond slowly, ventriculin is a much more rapid and effective treatment than nicotinic acid or other vitamins.

Owing to restriction of facilities, it has not been possible to conduct a more extensive investigation of the value of ventriculin in treating severe malnutrition in children. However, even with this limited material we feel justified in concluding that: (1) Stomach extract is a life-saving drug in severe infantile pellagra and should be given universal trial. (2) Stomach extract can be regarded as a lipotrope in view of the rapidity with which it depletes the fat from the liver in infantile and adult pellagra. (3) Biopsies reveal extensive liver damage in adult and infantile pellagra. (4) In view of the fact tha both adult and infantile pellagra respond to a single form of therapy, there is no justification for regarding them as different diseases.

We wish to acknowledge our indebtedness to Dr. Selby for allowing us access to the children under his care.

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[1] Trowell, H. C., *Trans. Roy. Soc. Trop. Med. Hyg.*, 35, 13 (1941).
[2] Williams, C. D., *Arch. Dis. Child.* 8, 423 (1933).
[3] MacVicar, N., *S. Afr. Med. J.*, 9, 892 (1935).
[4] Kark, S. L., *S. Afr. Med. J.*, 8, 106 (1943).
[5] Trowell, H. C., personal communication.
[6] Petri, S., *et al.*, *Acta Med. Scand.*, 93, 450 (1937).
[7] Bandier, E., *Acta Med. Scand.*, 101, 496 (1939).
[8] Sydenstricker, V. P., *et al.*, *Amer. J. Med. Sci.*, 192, 1 (1936).

## A Rapid Method of Estimating Moisture in Dehydrated Fish

THE determination of moisture in foods by extraction with alcohol has been limited by the lack of a rapid and accurate method of estimation of the resulting alcohol–water mixtures. Robertson[1] has recently shown that both dicyclohexyl and a mixture of seven volumes of 'Elaine' kerosene and one volume of Standard White Oil No. 7 (both products of the Standard Oil Co. of California) possess very critical temperatures of solution with water–alcohol mixtures. The critical temperature of solution is clearly demarcated by loss or appearance of turbidity with the paraffin mixture, but this is preceded by a hazy appearance with dicyclohexyl. As the method can be adjusted to give a range of up to 20° C. for a water content of 1 per cent in water–alcohol mixtures, the method appeared to be sufficiently critical for food analyses.

As neither dicyclohexyl nor the grades of paraffin mentioned by Robertson was available, a blend of Standard White Oils No. 5, No. 12, and liquid paraffin was used. This blend approximated to the physical characteristics of Standard White Oil No. 7. The critical temperature of solution was determined for water–alcohol mixtures of known low water content with (*a*) 7 parts of kerosene to 1 part of blended white oil, (*b*) 3 parts of kerosene to 1 part of blended white oil. The ratio of alcohol–water to paraffin mixture was kept constant at 2–4. The relationships so derived were used as reference curves for all subsequent determinations. These curves are not reproduced, as each particular mixture of paraffin has a different critical temperature of solution for the same amount of water.

The time required for extraction of water from any food by refluxing with absolute alcohol or with alcohol of low but known water content varies with the nature of the food. Extraction of water from 10 gm. dehydrated fish with 50 ml. of boiling alcohol reached equilibrium in 30 minutes. Only slightly less water was extracted in 15 minutes. The results obtained by the critical temperature of solution method and the more conventional methods of oven drying are compared in the accompanying table. The vacuum oven used was designed and constructed by workers at this Laboratory and gives quicker drying than the normal laboratory design.

WATER CONTENT OF DEHYDRATED FISH DETERMINED BY DIFFERENT METHODS.

| Sample No. | Per cent loss in weight | | |
|---|---|---|---|
| | Crit. temp. of sol. method | Vacuum oven 20 hr. at 70° C. | Oven drying at 100° C. |
| 1 | 9·5 | — | 9·2 (6)* |
| 2 | 5·7 | 5·8 | 6·0 (6½) |
| 3 | 7·7 | — | 8·1 (9) |
| 4 | 7·8 | — | 7·5 (7) |
| 5 | 8·55 | 8·1 | 8·5 (6) |
| 6 | 9·5 | 9·4 | 9·25 (6) |

* Hours of drying to give constant weight.

The results obtained by the three methods do not differ by more than 0·4 per cent except for sample 5, where there is a maximum difference of 0·45 per cent between the results obtained by vacuum oven drying and the critical temperature of solution method.

The samples determined were of four common South African fish of commercial importance with oil contents on a fresh-weight basis ranging from about 0·1 to 3·0 per cent.

The critical temperature of solution method can be recommended for rapid and accurate determination of the water content of dehydrated fish, since with this material there is rapid and complete extraction of water by alcohol and the necessary calibration curves need only be drawn up once for a single large consignment of kerosene and white oil. Where dicyclohexyl is obtainable, even this is not necessary, since the curve is given by Robertson[1]. It is necessary to take precautions to dry all glassware thoroughly.

Work is proceeding with other dehydrated products, including vegetables, but these latter present certain difficulties.

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[1] Robertson, G. R., "Estimation of Water in Alcohol with Aid of Dicyclohexyl", *Ind. Engineering Chem. A.E.*, 15, 451 (1943).

## Measurement of Potential Difference as a Method for Studying the Action of Water on Lead Pipes

WHEN working a R.A.M.C. mobile hygiene laboratory in Northern Ireland in 1941, I found that a number of the water samples submitted for examination had a definite plumbo-solvent action. Thresh[1] showed that mere acidity or alkalinity was of minor importance, but the presence of lime with a silicate or organic acid, such as citric, lessened the action.

Nine samples attacked lead; they were mostly acid and very soft. The customary routine was followed, freshly scraped and old lead surfaces being immersed and the effects noted. Such comparative tests can give an approximately quantitative determination of the rate of attack. Thus water from the Glen River, Newcastle, was at *p*H 5·8 and gave a strong reaction for lead after 20 minutes with a fresh surface. The source, recognized as dangerous, is regularly treated with sodium silicate. The water was then at *p*H 8 and gave only a slight positive test for lead after an hour; the new surface tarnished rapidly. Water from Castlewellan Lake, at *p*H 7·3 and with ten parts per million temporary hardness and thirty permanent, gave a negative result after twenty minutes and showed less lead after one day than did the untreated river water after twenty minutes.

The diverse chemical factors affecting the action of water on lead appear to be summed up by a measurement of the difference of electrical potential between old and new lead surfaces immersed in the sample. Differences of a few millivolts were, however, found between various old surfaces. Accordingly, the gold electrode, supplied with the potentiometer provided in the mobile hygiene laboratory for *p*H determinations, was used in measuring the potential difference between gold and old or new lead surfaces.

| Period of immersion | | Two min. | | Ten-forty min. | | About one day | |
|---|---|---|---|---|---|---|---|
| Sample | *p*H | Old | New | Old | New | Old | New |
| Distilled | 6·0 | 617 | 725* | — | — | — | — |
| River | 5·8 | 584 | 682 | 537 | 581 | 472 | 476–505† |
| River, with silicate | 8·0 | 507 | 506 | — | — | — | — |
| Lake | 7·3 | 514 | 556 | 390 | 396 | 282 | 390 |

* Obtained indirectly, 108 millivolts more than old surface.
† After stirring.

A few results are shown in the table, but pressure of routine work rendered it impossible to follow the changes at precisely regular intervals; the units are millivolts between gold and lead surfaces at about 12° C.

The treatment of the town supply with silicate is obviously very effective as the new surface is rapidly inactivated. Since the continuation of the work has had to be postponed, this outline of what appears to be a useful method is now presented; it is not mentioned in the 1942 edition of Thresh, Beale and Suckling's book "The Examination of Waters and Water Supplies".

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## Active Nitrogen and $N_2^+$ ($X'$) Ions

IN a recent paper[1] I put forward the hypothesis that active nitrogen is simply the positive ions of the nitrogen molecule, $N_2^+$ ($X'$) produced in the discharge tube. It was suggested that the excitation of the First Positive Bands—the characteristic active nitrogen spectrum—is due to the neutralization of $N_2^+$ by a three-body collision, with the neutral $N_2$ molecule as the third body, in the volume rather than on the surface of the discharge vessel. Thus, $N_2^+ (X') + e + N_2 \rightarrow N_2$ ($B$ state) $+ N_2$ ($A$ state). The energy relation is satisfied if the $N_2^+$ molecule, on neutralization, drops to a vibration level in the neighbourhood of $v' = 10$ of $B^3\Pi$ state (9·26 eV.). and the neutral $N_2$ molecule is raised to the $A^3\Sigma$ state (6·14 eV.). It is now pointed out that the transition of $N_2^+$ ($X'$) to $B^3\Pi$ ($v' \simeq 10$) on neutralization satisfies the Frank-Condon principle, namely, that the change in the nuclear distance (near turning point) is very small.

The remarkably long life of active nitrogen was attributed to the fact that the conditioning or special treatment of the walls of the discharge tube which is so essential for long life prevents recombination of the ions and the electrons taking place on the walls. The recombination thus being confined to the volume proceeds slowly by a three-body collision process, giving long life to the afterglow. In the present communication, certain properties of active nitrogen connected with the presence of ionization in the afterglow will be discussed, and it will be shown that they receive simple and satisfactory explanation on the above hypothesis.

The subject of ionization in active nitrogen has been studied by Constantinides[2] and in great detail by Lord Rayleigh[3]. Two of the experimental results of Rayleigh which have an important bearing on the present hypothesis are as follows:

(1) The ion density as computed from observation of ionization current flowing between two electrodes is *less* than the number of photons emitted per unit volume from the glowing gas (in the initial stage).

(2) Introduction of neutral $N_2$ increases the ionization current and also the intensity of afterglow.

These experiments require careful consideration as otherwise they can easily be interpreted as invalidating the proposed hypothesis. For example, according to the proposed hypothesis, the density of ions cannot be less than the number of photons emitted per unit volume. It will be shown, however, that the hypothesis not only offers a simple explanation of these apparently anomalous results but, in fact, is confirmed by them.

For explanation of (1) we recall that according to the hypothesis, the conditioning or treatment of the wall prevents the neutralization of electrons and positive ions on the glass surface. This, in other words, means that by some process—we do not as yet know how—the conditioned or treated wall prevents the electrons and positive ions from coming into contact with the surface. According to the hypothesis, therefore, ionization current between two electrodes (the surfaces of which, as in the experiment under consideration, are treated) will be extremely small compared to that which would otherwise be obtained if the electrode surfaces are normal and unconditioned. The ion density computed from currents carried by such electrodes would therefore be much smaller than the true ion density. It should be noted that even untreated metallic electrodes would not, as may at first sight be expected, yield better results. This is because such electrodes when immersed in active nitrogen become conditioned, as is evinced by the fact that they do not permit recombination on their surfaces. Perhaps metallic electrodes which can be warmed to 'poison' their surfaces would, if used, indicate the true ionization current.

These latter conclusions are based on another experiment by Lord Rayleigh[4]. It is found that a small piece of metal held in active nitrogen is ordinarily dark and is unaffected. If, however, it is warmed, or is not far from the direct discharge, it starts glowing presumably because active nitrogen begins to deliver energy to it. The obvious explanation of this experiment, on the basis of the present hypothesis, is that ordinarily no reaction takes place on the metal surface, because the metal immersed in active nitrogen becomes conditioned and prevents the access of ions and electrons to it. But if the conditioning is destroyed by any means (by warming or by putting the metal close to the discharge) then reaction on the surface starts and the released energy (15·58 eV. per electron and ion recombined) raises its temperature to a glow heat.

Increase of afterglow in experiment (2) is explained by the increase in the density of $N_2$, which causes an increase in the value of the recombination coefficient. The increase in the ionization current can be explained if it is assumed that the introduction of neutral $N_2$ from outside temporarily 'poisons' the electrode surfaces so that ions and electrons flow to them with less obstruction.

No other hypothesis so far put forward gives any explanation of the occurrence of ions in active nitrogen, or of the fact that the afterglow and the ionization in it are not wholly independent.

Closer examination shows that the hypothesis gives similar simple explanations of various other phenomena observed in active nitrogen even to small details. These and the explanations of the phenomena mentioned above are being examined by Mr. J. S. Chatterjee (Ghose Research Scholar in physics). Mr. Chatterjee is also arranging certain crucial experimental tests for the hypothesis. These will form the subject matter of a future communication.

If the proposed hypothesis of active nitrogen be correct, then the proper subject of investigation now would be the study of the change which the conditioning or the treatment produces in the walls of the

discharge vessel and which prevents the surface recombination of $N_2^+$ ions and electrons.

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[1] Mitra, *Science and Culture*, 9, 49 (1943–44).
[2] Constantinides, P. A., *Phys. Rev.*, 30, 96 (1927).
[3] Rayleigh, *Proc. Roy. Soc.*, A, 180, 146 (1942). See also, 86, 61 (1911) and 87, 183 (1912).
[4] Rayleigh, *Proc. Roy. Soc.*, A, 176, 17, 22 (1940).

## Derivation of Maxwellian Relaxation Times from Tensile Data

MAXWELL'S[1] relaxation time ($t_r$) is defined as the ratio of viscosity ($\eta$) to shear modulus ($n$), and is derived from the expression $-\delta(\log S)/\delta t$, of which it is the reciprocal ($S$ is the shear stress dissipating at constant strain).

It is well known that for fluids $\eta = \tau/3$, where $\tau$ is the "coefficient of viscous traction" (Trouton[2]), and for elastic solids, that $n = E/2\ (1 + \Pi)$, where $E$ is Young's modulus and $\Pi$ is Poisson's ratio, which is $\frac{1}{2}$ for fluids. But it is often overlooked that the latter expression is only applicable to small strains; there is also the question of isotropy, which will not be discussed here. Further, the validity of the former to flow conditions depends on the special nature of liquids (see especially Love[3]).

Now that the theory of elasticity is being increasingly applied to 'high-elastic' materials for which so-called 'moderate strains' may be of the order of several hundred per cent, it is important that the limitation of the $2(1 + \Pi)$ expression should be more widely realized. A number of authors (Schofield and Scott Blair[4], Kuhn[5], Bennewitz and Rötgers[6], Taylor[7], Robinson, Ruggy and Slantz[8], etc.) have derived relaxation times from tensile data for large strains using the $2(1 + \Pi)$ expression. In some cases it is quite clear that it is only the order of magnitude of $t_r$ that is significant: in others the limitations of the treatment are not made clear. The applicability of the expression does not depend only, as Simha[9] appears to suggest, on the constancy of $\Pi$ or on the validity of Hooke's Law: in fact, the meaning of this latter criterion is liable to ambiguity where large strains are concerned. The essential point is that the original calculation of $2(1 + \Pi)$ depends fundamentally on the deformations being small.

Fluid behaviour is defined in such a way that large strains must be expressed by the 'natural' formula

$$\int_{l}^{l_0} \frac{dl}{l} = \log_e l_0/l$$

(for a length increase from $l_0$ to $l$) and such strains are additive. The usual 'engineering' formula, $l - l_0/l_0$, is not additive for large strains and the 'extension ratio', $l/l_0$, which is much used in the theory of rubber structure (see Wall[10], Treloar[11], etc.), is multiplicative, being numerically equal to the antilogarithm of the 'natural' strain. Some authors, such as Latshaw[12], do not appear to be clear about this. The extension ratio has the advantage that it relates tensile to shear strains by a simple expression irrespective of strain magnitude[3].

Modern 'high-elasticity' theory is based largely on the work of Kuhn[5] and that of Alexandrof and Lazurkin[13], Lazurkin[14] and Gurevich and Kobeko[15]. This latter school is concerned with what are called by the authors 'relaxation times' but, being quite different from those of Maxwell, are now generally known as 'orientation times'.

The orientation time is the time required for a strain to reach $1 - 1/e$ of its equilibrium value under constant stress. Although said to apply only to super-cooled liquids, the materials concerned do not have that property of liquids which justifies the use of the classical expression relating tensile to shear conditions, since there is no unique rate of shear for any given stress. It is not clear whether orientation times refer to shear or to tensile-compressive strains. Alexandrof did compression tests whereas Gurevich and Kobeko used shearing conditions. The discrepancy does not appear to have been noted.

In fitting equations such as that of Nutting[16] which do not involve entities like viscosity and relaxation time, the empirical use of $2(1 + \Pi)$ is justifiable; but this is scarcely the case in deriving values of $\eta$ and $t_r$, unless it be made quite clear that the treatment may be only very approximate for large strains. For materials of high consistency, a relaxation time defined in terms of the dissipation of tensile stress and a coefficient of viscous traction would really be preferable to the more usual $t_r$ and $\eta$.

I have been helped in the unravelling of this very confusing situation by so many friends that individual acknowledgment is impossible.

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June 23.

[1] Maxwell, J. C., *Phil. Mag.*, 35, 129 (1868).
[2] Trouton, F. T., *Proc. Roy. Soc.*, A, 77, 426 (1906).
[3] Love, A. E. H., "A Treatise on the Mathematical Theory of Elasticity", 2nd ed. (Cambridge Univ. Press, 1906).
[4] Schofield, R. K., and Scott Blair, G. W., *Proc. Roy. Soc.*, A, 141, 72 (1933).
[5] Kuhn, W., *Angew. Chem.*, 52, 289 (1939).
[6] Bennewitz, K., and Rötgers, H., *Phys. Z.*, 40, 416 (1939).
[7] Taylor, N. W., *J. Appl. Phys.*, 12, 753 (1941); *J. Phys. Chem.*, 47, 235 (1943).
[8] Robinson, H. A., Ruggy, R., and Slantz, E., *J. Appl. Phys.*, 15, 343 (1944).
[9] Simha, H., *J. Appl. Phys.*, 13, 201 (1942); *Ann. N.Y. Acad. Sci.*, 44, 297 (1943).
[10] Wall, F. T., *J. Chem. Phys.*, 10, 132, 485 (1942); 11, 67, 527 (1943).
[11] Treloar, L. R. G., *Trans. Farad. Soc.*, 39, 36, 241 (1943); 40, 59, 109 (1944).
[12] Latshaw, E., *J. Franklin Inst.*, 234, 63 (1942).
[13] Alexandrof, A. P., and Lazurkin, J. S., *Act. Physicochim. (U.S.S.R.)*, 12, 647 (1940).
[14] Lazurkin, J. S., *Act. Physicochim. (U.S.S.R.)*, 12, 669 (1940).
[15] Gurevich, G., and Kobeko, P., *Act. Physicochim. (U.S.S.R.)*, 12, 681 (1940).
[16] Nutting, P. G., *J. Franklin Inst.*, 191, 679 (1921); 235, 513 (1943) *J. Amer. Soc. Test. Mats.*, 21, 1162 (1921).

## Smoke and Rain

IN a paper published in 1929[1] the conclusion was drawn from observations made in two or three different ways that smoke discharged into the atmosphere tends to promote rainfall and to precipitate rain in highly moist air when, without smoke, it would not have fallen. One test was to compute the rainfall on each day of the week, and the result showed that on an average of thirty years, Sundays had rather less rain than weekdays by about 6 per cent, or more correctly, the average of weekdays had an excess over Sundays by this amount. As factories in Rochdale and neighbouring Lancashire towns do not work on Sundays there is then a general absence of smoke in the air, although

domestic smoke, which is of less importance, continues. The outpouring of factory smoke on working weekdays was considered to be the cause of the excess of rain on weekdays over Sundays.

Since the results of thirty years rainfall were published fifteen years have passed, and the rainfall for each day of the week for this later period has again been computed and has been combined with the previous thirty years so that a total of forty-five years is now available. The following are the average annual amounts of rain in inches for each day of the week (1) for the thirty years, 1898–1928, (2) for the forty-five years, 1898–1943 :

| | Sun. | Mon. | Tues. | Wed. | Thurs. | Fri. | Sat. | Average | Total |
|---|---|---|---|---|---|---|---|---|---|
| (1) | 6·17 | 6·88 | 6·68 | 6·49 | 6·65 | 6·27 | 6·63 | 6·54 | 45·77 |
| (2) | 6·01 | 6·44 | 6·30 | 6·45 | 6·40 | 6·25 | 6·56 | 6·34 | 44·41 |

From this it is seen that the excess of rain on weekdays over Sundays, which was shown in the thirty years record, is again clearly in evidence in the longer record of forty-five years, a period long enough to make it improbable that the result is fortuitous.

It would not, however, have been surprising if the difference in rainfall between Sundays and weekdays had become less marked as time progressed, since electric power, supplied from a distant source, has in recent years replaced, to a considerable extent, steam power with its attendant pollution.

Unless there is a natural seven-day period in rainfall with its minimum occurring on Sundays, which may be ruled out, the conclusion is that the result found above is due to human agencies, and the most probable agency is smoke in the atmosphere.

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*Quart. J. Meteor. Soc.*, 55 (Oct. 1929).

## Scientific Research

IN *Nature* of May 6, I find a very interesting and very hopeful discussion of the problems of scientific research in Britain. Yet it seems to me that there are some aspects of the matter which have not been sufficiently considered.

(1) The cultural value of research. It appears to be generally assumed that the purpose of science is almost wholly that of increasing material wealth. Surely it has also another purpose, perhaps no less important, that of enabling man to understand and appreciate the world he lives in. This cultural aspect, rightly understood, justifies scientific work which may have no significance or relation to material wealth. It is here that science is connected with literature, with poetry, with the emotional life of mankind.

(2) Certainly the remuneration of scientific workers should be increased, but it is difficult to say what that remuneration is in any given case. In the universities, men are paid primarily as teachers, and do what scientific work they can, or wish. But undoubtedly they are appointed to their positions partly on account of their scientific standing, and thus are indirectly paid. It is a curious circumstance that museums expect to get scientific workers to spend months or years in the study of their collections, without any thought of payment. On the contrary, they expect the workers to show gratitude for permission to study the collections, and they do show it, fully appreciating the work which has been done, and the expense incurred, in assembling the materials.

(3) Provision must be made for adequate publication. Young men, entering upon a field of research, will not spend years on a revision or monograph which may never see the light. Not only should large and important works be published but also (as is customary) shorter papers to keep the scientific world aware of what is going on, and encourage co-operation. But still another sort of publication is needed. We need more small, well-illustrated books, written in simple language, to interest the general public in scientific work.

In all these matters, very considerable progress has been made in Great Britain, but when scientific work is under discussion they should not be overlooked.

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## Importance of Film Records

A NUMBER of amateurs are making films frequently of unique scientific interest. It may be that by patience an ornithologist has managed to secure some pictures of bird behaviour which may never be duplicated for a generation or more. It may be that a medical man has made a motion-picture record of a rare case-history or a film of a particular method of conducting an operation. It may be that an anthropologist has secured film records of fast disappearing tribal ceremonies or, in the case of our own country, a folk survival. Any worker in any field may indeed make a record which has more than a personal interest.

Most amateurs work on negative reversal stock if they are taking black and white pictures. No master negative, therefore, exists. The same is even more true of the colour films which amateurs are tending increasingly to use. The result is that each time the film is run through the projector, it depreciates slightly in quality. In the end it wears out, and people are thenceforth denied the knowledge which only this film can give.

To make a black and white negative from which prints can be taken or to make a master copy of a colour film from which other copies can be taken is relatively inexpensive ; but nevertheless it is usually beyond the individual's pocket. In any event, is there any reason why he should make a special negative or copy to meet a hypothetical demand if other people do not share his views as to the importance of the topic ?

So valuable film records are disappearing. Is there any means by which this may be prevented ? Would learned societies, for example, be willing to set up special committees to appraise the value of any films submitted to them and, if they reach the requisite standard, would they be ready to put on one side sufficient funds to make a master copy for preservation ? Can any of the big trusts be persuaded to interest themselves in making available something of the order of not more than £1,000 a year in order to set such a scheme going ? Is there any point in this Institute convening a conference to obtain expressions of opinion ?

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# THE YEW TREE (*TAXUS BACCATA*)

By ALEXANDER L. HOWARD

"The warlike Yew by which more than the lance
The strong arm'd English spirits conquer'd France."
DRYDEN.

THIS romantic but rather sombre tree has for long ages been connected in simple country minds with superstitious stories of illness and death. All the old authorities on trees have lurid tales to tell of its poisonous effect on both man and beast, and it is therefore not surprising that the yew has never had a fair chance in England, but lived out its long life with little help or encouragement.

As long ago as 1662 John Evelyn wrote:

> "Since the use of bows is laid aside among us, the propagation of this tree is quite forborne. But the neglect of it is to be deplored; seeing that the barrenest grounds, and coldest of our mountains, might be profitably replenished with it."

Much has been written, and many reasons advanced for its invariable proximity to churches and graveyards. It has been suggested that this may have been partly to secure its continued cultivation on account of its value for bow-making, partly to safeguard cattle from its poisonous leaves, and partly because its rather sombre evergreen branches made of it a fitting symbol of death and immortality. The first of these cannot be accepted—the quality of the yew grown in England appears to have been inferior to that obtained from Spain, for Boulger says:

> "It was to bows of Yew that we mainly owed the victories of Crecy and Poictiers; and Edward IV enacted that every Englishman should have a bow of his own height. English Yew-wood, however, for this purpose, only fetched one-third the price of that which was imported."

Further, the greater number of, if not all, the yew trees by churches are living, nor have we any record of any being felled for bow-making. Mr. Teulon Porter also tells me that in past days the parson's revenue partly consisted of the licence to feed cattle in the churchyard, which negatives the second reason: we must accept the last as being the most probable.

Throughout the ages yew has been used as an emblem of death and burial, and this custom, which is even mentioned in ancient Greek and Roman records, has insensibly become a universal tradition, very ably expressed by Johns:

> "Generation after generation might be gathered to their fathers, the Yew tree proclaiming to those who remained that all like the evergreen unchanging Yew were yet living in another world, the life which had been the object of their desire."

"Of all the trees in England,
Oak, Elder, Elm and Thorn,
The Yew alone burns lamps of peace
For them that lie forlorn."
WALTER DE LA MARE (1873).

and

"My shroud of white, stuck all with Yew."
SHAKESPEARE.

The yew has a short irregular bole, with strong-limbed branches somewhat resembling those of the hornbeam in habit of growth. These are densely covered with a dark green cluster of needle-like leaves spreading widely with a broad crown. Some of the trees are brightened at intervals by clusters of golden or red berries, according to the variety.

It shares with the oak the claim to live the longest life of any tree grown in Great Britain, but Elwes thinks that its great age has been much exaggerated by many authors, particularly the great Swiss botanist De Candolle. Elwes refers his readers to Lowe, who proves "that the average rate of growth is about 1 foot of diameter in 60–70 years in both young and old trees". He also says that there is:

> "abundant evidence to show that though old trees grow at intervals much more rapidly than young ones, they do not grow uniformly but have periods of comparative rest, and that the increase of girth is fastest when old trees have lost their heads and the stem is covered with young shoots.
>
> No tree has such a remarkable faculty of covering up wounds or injuries by the growth of fresh wood from the outside, and even after the main stem is completely dead, fresh and entirely new stems may grow up around it and form a new tree around the dead one. For this reason most of the yews of very large size are mere shells, and even when no hollow can be seen from the outside, decay—which is often indicated by moisture running from holes in the trunk—has set in."

It is impossible in this article to enlarge upon this question of the age, about which many authorities have already written extensively, but after exhaustive inquiry into the history of a number of yew trees, and study of the growth of many that have been felled, I am inclined to the view that the ages claimed by tradition may be correct.

It is equally impossible to enumerate the many outstanding examples of yew trees which have been commented upon by all authorities since Evelyn's time, but some are specially worthy of mention. Elwes describes in his "Timbers of Great Britain and Ireland" trees at Midhurst:

> "They consist of four avenues of yew trees forming a square of about 150 yards, together with a grove of yews at the upper end which average, as nearly as I could measure them, about 75 feet in height, but some probably exceed 80. These trees are for the most part sound and healthy, though little care has been taken of them, and some have fallen. They are remarkable not only for their great height, which exceeds that of any other yews on record in Europe, but on account of their freedom from large branches, many having clean boles of 20–30 feet, with a girth of 8–9 feet."

Mr. Thomas Roberts of Cowdray informs me that these avenues are in good healthy condition to-day (1944). Elwes also refers "to the largest pure yew-wood in England on the downs three miles west of Downton, Wilts, on the property of the Earl of Radnor" partially planted, and adds an account of "The Little Yews"—another wood near by, which contains much finer trees. He says:

> "the Cherkley Court Yew Wood is the best in England. . . . The wood covers an area of 50 to 60 acres in a shallow valley forming part of the old Ashurst estate, about three miles from Leatherhead in Surrey, on the east side of the old pilgrims' road to Canterbury."

Another is at Castle Eden Dene in Durham.

With the knowledge we have of these outstanding plantations, which date from very early times, we conclude that there must have been a far greater interest in its cultivation than that which has obtained for the last three hundred years or even more. This view is supported by the fact that it amounted to almost a penal crime to make use of any yew wood

other than for bows prior to the year 1550. It is likely, therefore, that the demand was so great that the better quality was becoming scarce, and even at that early date it was found necessary to import supplies from Spain.

It appears also that at a very early date it became fashionable to plant yew walks. One such walk still flourishes to-day at Huntington Castle, Clonegal, Ireland, and regarding this Mr. Manning Robertson writes to me under date of June 27, 1944, as follows:

"This consists of 122 trees in a row: the row is some 360 feet long and there are 'return ends' making three sides of a rectangle. The largest tree is 41 feet high and 12 feet 9 inches girth at 5 feet from the ground. Many of the trees have interlaced and grown together—like Banyan trees. Little is known of the Walk's history, but it is almost certainly monastic, and tradition has given the age as 600 years: it is still in perfect condition."

Elwes mentions:

"a remarkably fine yew walk at Hatherop Castle, Gloucestershire . . . which is supposed to be about 300 years old, in which the trees average about 60 feet in height with a girth of 9 to 12 feet."

The importance of the yew as hedgerow has been recognized for many centuries. Its use for the partition of fields has been debarred because of the danger to animals. Although it is slow in growing to perfection, as protection for property it has been for long ages justly prized, and is not only very decorative but also presents a formidable barrier, impossible to climb and very difficult to destroy.

John Evelyn evidently felt strongly on the question of yew hedges, as he wrote:

"the Yew tree has been generally cultivated for the pleasure garden, to be clipped into the shape of beasts, birds, etc., or for hedges. Whoever is pleased with such figures can raise no tree more proper for the purpose, as the branches and the leaves may be clipped and fashioned into almost any form or shape. But as this method is justly exploded, and as everyone who has the least pretension to taste, must always prefer a tree in its natural growth to those monstrous figures, the Yew is now chiefly planted for wilderness quarters, and for hedges, for which service it is excellently well adapted."

With regard to its uses for timber, and quoting from "The Timbers of the World":

"This useful and highly decorative wood is now little known or esteemed, although it presents qualities which deserve much better recognition. If the economic use of domestic woods were practised in this country as it has been in France and Germany, yew would have undoubtedly been brought into prominence. The colour is pale red, somewhat like cherry wood or pencil cedar: it has a beautiful smooth lustrous grain. Sometimes it is handsomely figured, and occasionally has a burr growth, the produce of which will compare favourably with amboyna, and has indeed actually been mistaken for it. The strength and elasticity of yew-wood has been known for centuries, particularly on account of its use for bows. . . . At Sir Mark Collet's house, near Sevenoaks, some handsome doors are made of yew. The stiles and rails are of the ordinary figured wood, and the panels of exceptionally fine figured burr. The colour has deepened with long exposure, assisted by careful polishing, and is now a rich red brown. Yew is particularly suited for chair-making, and some very fine specimens of considerable antiquity are to be found in many places. Elwes alludes to an extremely handsome arm-chair in Hornby Castle, the property of the Duke of Leeds. The date is about 1550. It is made of Yew, which adds to its rarity, for up to this time it was practically penal to employ yew-wood for any other purpose than the manufacture of the national weapon; in this instance the wood has become close, as hard as steel, and of a beautiful dark amber colour. The wood, though it is difficult to obtain, is also valued for brush-backs."

Yew is specially liable to the growth of 'burrs', which I have already mentioned. About thirty years ago an outstanding example was sent to me from the Caucasus, measuring more than seven feet in length, more than four feet in depth, and weighing nearly a ton. Purchased by an American, it was cut into veneer, yielding some of the finest specimens of yew burr ever seen.

It is difficult to decide whether this unique tree should be extensively cultivated; but it is certain that as a tree it has many interesting and unusual qualities, and as timber it is a fine medium for decorative work of all kinds.

## THE UNIVERSITIES AND INDUSTRY

THE "Report on the Extension of Scientific Research in Manchester University, particularly in Relation to the Industries of its Area" (Manchester University Press, 1944, 1*s*.) which has been prepared by a committee of professors and industrialists, all of whom are members of the governing bodies of the University, to assist the University to make a considered estimate of the increase in income necessary to ensure that its science departments may undertake their proper responsibilities in the nation's economy, is of much more than local interest. In the first place, it amplifies some passages in the recent pamphlet of Sir Ernest Simon on the development of British universities, while at the same time it offers some measure of the value of the Joint Standing Council of members of the University of Manchester and the Manchester Chamber of Commerce which has been under discussion between the two bodies, as announced by Mr. A. H. S. Hinchliffe at the last of the series of meetings on "Science and Industry" arranged by the Chamber. Again, in its chapter on research and teaching, it puts concisely much of the argument advanced in the recent House of Commons debate, by the Parliamentary and Scientific Committee and elsewhere, and attempts to give concrete expression to the means by which those arguments may be given effect.

The statement includes detailed reports from the Chemistry and the Electro-Technics Departments, which have been chosen because of their relevance to some of the more important scientific industries of the area. The first of these reports comes from Dr. C. J. T. Cronshaw, Prof. A. R. Todd and Prof. M. Polanyi; and the second is by Dr. A. P. M. Fleming and Prof. Willis Jackson. The broad conclusion reached is that the effective discharge of the functions of the science departments of the University of Manchester in the post-war period involves doubling the expenditure of the Departments as a whole. Even this would provide for no new developments outside existing departments, and the report proposes an increase of about 50 per cent in the first year, rising to 100 per cent in the fifth year after the War.

In its introductory survey of research and teaching, the statement emphasizes that the primary duty of the science departments must be research at the highest levels of which they are capable. The first step towards improving teaching standards in any

scientific department must be to increase the facilities for, and the volume and pace of, research. The expansion of research facilities in the science departments is thus placed first in order of importance; it comes before the expansion of student numbers, because the standard of a university depends on it.

Deprecating the distinction between 'pure' and 'applied' research, the statement prefers to speak of 'academic' and 'industrial' research, distinguishing the different modifying and conditioning factors which surround the same intellectual process. The outlook, approach and method of the research worker are the same whether he is in a university or in industry. Development work, which is the conversion of results of research into processes of economic production, depends for its success on men in industry who combine scientific knowledge with experience of practical problems in their particular field. The statement suggests that the flow into industry of men who have graduated in a strong science department, who have learned as postgraduates an outline of research technique, and who keep in touch with the work of academic laboratories, will reduce very materially the time-lag between research and development. The real and permanent link between university science departments and industry is in research.

Pursuing this argument, the chapter on post-war development in chemistry, from its review of the development of chemical industry in Germany, argues that a first-class scientific industry cannot be built up in the absence of first-class universities which are teaching science; while, on the other hand, such universities cannot long continue to function in the absence of an industry capable of exploiting scientific developments and willing to employ scientific staffs trained in them. The organic chemical industry in the past has been built up on coal and can continue to be based on coal in spite of the threat of the natural oil fields seeking new outlets for their new materials; and the statement urges that without an intensive research effort, both by industry and by the universities, comparable with that taking place in the United States, the organic chemical industry in Great Britain will falter and a great natural asset, coal, will be playing a lesser part in world development than is its due share. Besides the plans for an increased flow from the university of research chemists—representing in detail a department with an annual intake of fifty honours students and a total of some eighty research workers (including staff)—a flow from industry is recommended, such as the practice of releasing senior men in industry to pursue research in academic schools, for say two-year periods, and facilities for academic workers to visit other centres abroad for limited periods.

The following report, on post-war developments in electro-technics, similarly urges that what is particularly needed by the engineering schools is a scheme for the return, for limited periods, of selected men from industry. In the period between the two wars Great Britain lagged behind other industrial countries in the production for world consumption of those engineering goods and tools of production which result from the application of recent scientific and technical research and invention. This was a direct consequence of our inadequate research activity in the branches of science concerned, and in electrical engineering the effect was particularly marked on the telecommunications side. If, however, those university physicists and engineers who, either in their university departments or elsewhere, have contributed so much to the war-effort, are given comparable research facilities in the post-war period, the intimate liaison between university scientific workers and their industrial colleagues which has been established will develop to the great benefit of both the universities and industry, and of the country as a whole. Collaboration between the engineering schools and industry is particularly desirable in the attack on the border-line subjects between pure science and engineering, especially in the study of the properties of materials in relation to their chemical composition and physical structure.

With regard to the Manchester Department of Electro-technics, an increase in the number of undergraduate students to an average of twenty to twenty-five a year is suggested, and accommodation for up to ten men in each of two postgraduate courses. Even if some of the postgraduate teaching is conducted by part-time specialist lecturers from the local industry, the scheme will involve doubling the present full-time staff, with a further supplement to the laboratory staff. On a rough estimate, a further £20,000, based on pre-war costs, spread over the five-year period, will be required to bring the laboratories into a condition to initiate the scheme.

The statement does not touch on the question of a School of Chemical Engineering in Manchester raised by Sir Ernest Simon in his pamphlet. The spirit and trend of the statement, however, suggest that the Joint Standing Council at present under consideration may not only stimulate further the contact between the University of Manchester and the industries of the north-west of England, but also facilitate inter-regional consultation with regard to the founding of new schools where they will best serve national needs and not merely local interests or prestige.

## DEVELOPMENT OF THE CARIBBEAN REGION

THE report of the West Indian Conference held at Barbados during March 21–30, 1944 (Colonial No. 187. H.M. Stationery Office, 1944. 6*d*. net), contains accounts of the findings of the six committees which considered the agenda of the Conference. One of these specifically considered the Caribbean Research Council and possibilities for its expansion. In addition to the existing Sectional Committee on Agriculture, Nutrition, Fisheries and Forestry, the establishment of four further sectional committees is recommended, for public health and medicine, for industries, for building and engineering research, and for social sciences. Creation of a statistical unit to serve all sectional committees is recommended; and also early consideration by the Research Council of legal and fiscal problems related to collaboration among the research institutions of the Caribbean, with the view of submitting proposals to the Anglo-American Caribbean Commission for possible consultation with the Governments concerned.

Three general points are emphasized by the committee considering the Caribbean Research Council. First is the importance of freedom of action and independence of thought for the Research Council and its technical experts in the sectional committees, within the terms of reference specified by the Anglo-American Caribbean Commission. The Research

Council should also provide that the programmes of work of the several sections are properly co-ordinated, and that the projected investigations of Caribbean problems are approached with the view of yielding early results. Secondly, the activities of the Caribbean Research Council and the implementation of its findings depend ultimately on an enlightened public opinion among the Caribbean peoples themselves, and therefore on an improvement of their educational standards. Thirdly, the Research Council should give due consideration to the related work of institutions outside the Caribbean area and to such international agencies as may be created in pursuance of proposals made by the Hot Springs Conference on Food and Agriculture.

The extent to which opinion in the Caribbean is becoming aware of the research needs of the area may be seen in a number of proposals made by delegates in the reports of the committees dealing with other items on the agenda of the Conference. The committees concerned with means for raising the nutritional level both included such proposals in their reports. That dealing with increased local food production urged that research in the development and adaptation of foods of high nutritional and protective value and in cognate matters should be intensified through the medium of the Caribbean Research Council, and the necessary personnel provided to undertake extended programmes of research. That concerned with expansion of fisheries, after endorsing the findings of the Fishery Committee of the Anglo-American Caribbean Commission meeting at St. Thomas last August, urges that its recommendations should be implemented without delay. The Fishery Experimental Station at Mayaguez, Puerto Rico, should be a centre for technological research and a bureau for the collection and dissemination of statistics and information as well as undertaking fundamental and biological research. The most pressing lines of research are, in technology, on the capture of fish and on its handling and preservation; in biology, biological research which is necessary for the intelligent development and conservation of the fisheries, including studies on dominant species of fish, fish histories, productivity and depletion, migrations, seasonal schooling and spawning, and environmental studies on contrasted types of fishing grounds. Besides research in oceanography, such as an ecological study of the environments in which fish live, long-term fundamental research will be necessary to provide background information for the intelligent management and development of the fisheries, and as an informed basis for measures of conservation. The establishment of a fishery research institute in the British West Indies will be necessary, and such a scheme should be co-ordinated with any plans for the establishment of a University of the West Indies, or it should be affiliated to the Imperial College of Tropical Agriculture. Fishery research institutes and experimental stations should frame their research policy in accordance with the practical needs of the industry and co-ordinate their programmes on a regional basis.

This sectional report also recommends that an exploratory fishery survey in the Bahamas and Caicos, investigations on fish handling and preservation and net preservation, under local conditions, and on the commercial possibilities of sharks, crawfish, conchs, turtle and shrimp should be undertaken without delay; and that the attention of the Caribbean Research Council should be directed to the necessity for collecting and disseminating information on the commercial possibilities of sharks, the crawfish industry in the Bahamas, fresh and brackish water fish-culture and on sport fishing.

The report of the committee which considered the planning of public works for the improvement of agriculture, education, housing and public health includes a recommendation for the establishment of a Caribbean Planning Commission as part of the Anglo-American Caribbean Commission. It also recommends the institution for research on standardization of building units in various materials and the possibility of prefabricating such units in the Caribbean area, including the scientific pretreatment of lumber and standardized timber units against termite and rot at depots in each territory or group of islands.

The committee which considered industrial development recommends that the Government should help to create and to foster new industries and the development of existing industries which could survive without continued State assistance, either by undertaking research itself or by supporting approved investigations, the results of which should be made available at once to the whole area. Such research might include the erection of pilot plants at the public expense.

These and other recommendations of the sectional committees were adopted by the Conference, which further recommended that another session should be held within twelve months, and that the Anglo-American Caribbean Commission should consider the establishment of a permanent secretariat to handle the work of the Conference. Besides the emphasis thus laid on research, however, the Conference is of more than local interest as an example of Colonial regionalism in which an effective expression is given to the democratic spirit.

# POSSIBLE RELATION OF LINOLENIC ACID TO THE LONGEVITY AND GERMINATION OF PINE SEED

By DR. N. T. MIROV
U.S. Forest Service

SEEDS of some pines, such as Jeffrey pine (*Pinus jeffreyi*), can be stored in air-tight jars at room temperature for a long time. Even after ten years of storage one may expect as much as 40 per cent of viable seed. When the seeds of Jeffrey pine are sown in a greenhouse they germinate rapidly and abundantly. Many other pines, as, for example, sugar pine (*Pinus lambertiana*), have short-lived seed. Under ordinary storage conditions sugar pine seeds lose their viability rapidly, and after five years of storage their germination is usually nil. At 5° C. the viability of sugar pine seed is maintained for a long time; in one case, after eight years of cold storage, germination amounted to 86 per cent of the original. Normally seeds of sugar pine sown in a greenhouse either fail to germinate completely or give a very small percentage of germination. When, however, the seeds are chilled in some moist medium for three months at 5° C., they germinate as well as those of Jeffrey pine. This prolonged period at a low temperature, necessary for germination of refractory seeds, can be designated as the period of incipient germination.

Food storage materials of seed of the two pines are composed chiefly of fatty oil (55·5 per cent in sugar pine seed and 50 per cent in Jeffrey pine seed), proteins and sugars. It is seen that more than one half of the reserve food material in seeds of both pines consists of oil, and that sugar pine has more of it than Jeffrey pine. Analyses have shown that the oil of sugar pine seed has an iodine value of 150·5 while the oil of Jeffrey pine seed has an iodine value of 136·4. There is thus a higher degree of unsaturation in the seed oil of sugar pine.

In ordinary storage the most unsaturated component of the pine seed oil—linolenic acid—disappears gradually in all seeds but more rapidly in sugar pine than in Jeffrey pine seed. In the seeds of both species stored at 5° C., on the contrary, no appreciable losses in linolenic acid were detected. When sugar pine seeds were chilled in moist sand for three months, only traces of linolenic acid were found at the end of that period. Prolonged storage at ordinary temperatures results in decrease of germination capacity of sugar pine seed, whereas chilling in moist sand results in an increase; yet in both cases linolenic acid disappears.

Although a possible role of unsaturated fatty acids and especially of linolenic acid in germination and longevity of oleaginous seed has received very little attention, its importance in biological oxidation has been emphasized by Meyerhof[1]. This author discussed at length Warburg's findings that "of all the unsaturated acids, linolenic acid alone with its three double linkages shows autoxidation with iron". During autoxidation the number of double bonds decreases and the reaction proceeds as follows:

$$CH_3.CH_2.CH = CH.CH_2.CH = CH.CH_2.CH = CH(CH_2)_7.COOH$$

$$\begin{array}{c} | \\ CH \\ \| \\ CH \\ | \end{array} + O_2 + H_2O = \begin{array}{c} | \\ CHOH \\ | \\ CHOH \\ | \end{array} + O = \begin{array}{c} | \\ CHO \\ | \quad | \\ CHO \\ | \end{array} + H_2O.$$

Meyerhof distinguishes between the reaction *in vitro* where it stops on the conversion of linolenic acid into slightly oxidized products, and a reaction *in vivo* where it progresses as far as formation of carbon dioxide.

In stored seed where life processes are hindered, conditions perhaps are similar to those existing *in vitro*. Slightly oxidized products are formed and these are gradually polymerized into inactive substances. The degradation of the unsaturated acids, and especially of the linolenic acid, proceeds faster in sugar pine seed than in Jeffrey pine seed. During the incipient period of germination of sugar pine seed the conditions may be similar to a reaction *in vivo*. Here disappearance of linolenic acid is probably connected with respiration and also with transformation of fats into carbohydrates.

The final results in both cases are precisely the same, namely, disappearance of linolenic acid, but the course of oxidation is quite different. In one instance it possibly causes death of the seed, while in the other it probably represents the first stage of germination connected with the utilization of stored food materials.

Of course, variations in linolenic acid contents in the seed of the two pines do not explain yet why Jeffrey pine seed germinates well under ordinary conditions and sugar pine seed does not. The experiments show that it might be connected with differences in the status of growth hormone in the seeds of the two species, but the discussion of this phase of germination is beyond the scope of this paper.

[1] Meyerhof, Otto, "Chemical Dynamics of Life Phaenomena" (Philadelphia and London, J. B. Lippincott Co., 1924).

## ASSOCIATION OF UNIVERSITY PROFESSORS AND LECTURERS OF THE ALLIED COUNTRIES IN GREAT BRITAIN

### ANNUAL MEETING

THE fifth general meeting of the Association of University Professors and Lecturers of the Allied Countries in Great Britain was held in Cambridge during June 24 and 25, 1944. It was the annual meeting, a sequel to the annual meeting of 1943 held in Oxford, and a special significance was attached to it as a friendly gathering, as well as a business meeting, in view of the not unreasonable expectation that the members may have separated to their own countries before the next annual meeting falls due.

The morning of June 24 opened with meetings of Section IV (Student Affairs), chairman, Prof. R. D. Laurie (Great Britain); Section VIII (Modern Humanities), chairman, Prof. L. E. Genissieux (France); and Section IX (History), chairman, Dr. de Sturler (Belgium). Then all Sections met for a lecture on the history of the Cavendish Laboratory by Sir Lawrence Bragg. The afternoon followed the same pattern: meetings of Section II (Collaboration with International Bodies), chairman, Prof. J. Timmermans (Belgium); Section V (Law), chairman, Prof. B. Helczynski (Poland); Section VI (Science and Technology), chairman, Prof. A. Photiades (Greece); and Section VII (Economy), chairman, Prof. J. A. Veraart (Netherlands), and after tea in the gallery of Emmanuel College a lecture by Prof. G. M. Trevelyan on the history of the University of Cambridge.

On June 25 the General Assembly met, and was welcomed by the vice-chancellor, Dr. T. S. Hele, master of Emmanuel College.

The president of the Association, Prof. J. Timmermans, then gave his address, which was a résumé of the year's work and progress. He pointed out that it has been a period of consolidation but that also there have been new departures. The Executive Committee had found sufficient work to require a meeting each month, with two in May. An Education Conference was held in April on lines similar to that held in the spring of 1943, and the British Council again guaranteed a very considerable contribution towards defraying the cost of publishing the report. The Publicity Committee, under the chairmanship of Prof. Photiades, carried through the publication of *Communication*, addressed to members, of which three numbers have already appeared and of which some half-dozen are planned to be produced during twelve months. Prof. Timmermans reviewed the activities of members of the Executive Committee in relation to other organizations having similar interests, notably the Conference of Allied Ministers of Education, the London International Assembly, the British Association Committee on Post-War

University Education and the International Relations Committee of the Association of University Teachers. One of the most conspicuous developments of interest to the Association during the year was the events following the visit of the American education delegation. This delegation co-operated with the Conference of Allied Ministers of Education in producing a scheme for a United Nations Organisation for Educational and Cultural Reconstruction, which is now under consideration by the United Nations Governments. It is the hope of the Association that it will be able to establish useful contacts with this important Organisation.

Dr. Grayson N. Kefauver, who represents the United States Government in connexion with the development of the United Nations Organisation for Educational and Cultural Reconstruction, was present, and addressed the meeting. He explained the attitude of the United States and the purpose of the new Organization, and welcomed the suggestion of co-operation from the Association of Allied University Professors.

The reports of the various sections were then received by the Assembly, indicating that a considerable amount of work is in hand on a variety of topics. Arising therefrom it was resolved on the recommendation of Section IV that the Memorandum on Student Health which was printed in No. 1 of *Communication* be adopted.

The afternoon session was devoted to a discussion on the draft statutes of the proposed International Association. The importance of a thorough discussion was recognized by all, and it was felt undesirable to proceed to final decisions at this meeting as this was the first occasion on which the General Assembly had had an opportunity of expressing its views. The Executive Committee was asked to undertake some redrafting in the light of the discussion, for presentation to the next general meeting.

Prof. J. A. Veraart (Netherlands) was elected president for the session 1944–45. Other members of the Executive Committee were elected as follows: Belgium, Prof. J. Timmermans; Czechoslovakia, Prof. V. Klecanda; France, Prof. P. Vaucher; Great Britain, Prof. R. D. Laurie; Greece, Prof. A. Photiades; Netherlands, Prof. J. A. Veraart; Norway, Prof. A. Sommerfelt; Poland, Prof. B. Helczynski; U.S.A., Prof. A. L. Goodhart; Yugoslavia, Prof. S. Yovanovic.

## APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (temporary) IN PHYSIOLOGY—The Registrar, King's College, Newcastle-upon-Tyne 2 (August 16).

ASSISTANT MASTER to teach SCIENCE SUBJECTS to Junior Technical Classes and to Apprentice Day Classes in the Mill Street School of Building, Manchester—The Director of Education, Education Offices, Deansgate, Manchester 3 (August 16).

SENIOR TECHNICAL OFFICER on the staff of the Northamptonshire Institute of Agriculture, Moulton, Northampton—The Secretary for Education, County Education Offices, Northampton (August 18).

ASSISTANT LECTURER IN METALLURGY—The Registrar, The University, Leeds 2 (August 19).

ASSISTANT LECTURER IN BOTANY—The Registrar, The University, Manchester 13 (August 19).

ASSISTANT MASTER to teach MECHANICAL ENGINEERING SUBJECTS in the Stockton-on-Tees Technical School and Evening Institute—The Director of Education, Shire Hall, Durham (August 19).

SPEECH THERAPIST—The Director of Education, Town Hall, Ilkeston, Derbyshire (August 19).

AGRICULTURAL CHEMIST—The Principal, Agricultural Institute and Experimental Station, Kirton, Boston, Lincs. (August 19).

ASSISTANT PSYCHOLOGIST—The Chief Education Officer, 2 Cecil Road, Bristol 8 (August 21).

LECTURER (temporary) IN PHYSICS—The Registrar, University College, Southampton (August 21).

RESEARCH MANAGER to an Engineering Company in the Midlands (must possess an Honours Degree in either Engineering or Physics)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. A521.XA) (August 21).

CIVIL ENGINEER by an Airways Corporation for Constructional Work in India and Burma—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.1069.XA) (August 21).

SPEECH THERAPIST—The School Medical Officer, County Hall, Chichester (August 23).

SENIOR POST under the Aeronautical Inspection Directorate (must possess a Degree in Metallurgy or recognized equivalent)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.1155A) (August 25).

ASSISTANT MASTER (Graduate) to teach PHYSICS and some MATHEMATICS in the Sheffield Technical School—The Director of Education, Education Office, Leopold Street, Sheffield 1 (August 26).

READERSHIP IN PHYSICAL ANTHROPOLOGY—The Registrar, University Registry, Oxford (August 31).

SECRETARY to the Editorial Board of the 'Transactions' (must hold a Degree in Physics, Metallurgy or Engineering of a British University, or an equivalent technical qualification)—The Secretary, Institute of Welding, 2 Buckingham Palace Gardens, London, S.W.1 (August 31).

CHIEF ELECTRICAL ENGINEER AND MANAGER—The Town Clerk, Town Hall, Chichester (August 31).

BOROUGH ELECTRICAL ENGINEER AND MANAGER—The Town Clerk, 4 Woodville Terrace, Gravesend, Kent (September 1).

UNIVERSITY CHAIR OF STATISTICS tenable at the London School of Economics—The Academic Registrar, University of London, South Kensington, London, S.W.7 (September 4).

CURATOR OF THE CITY MUSEUMS—The Town Clerk, Room 57, Civic Hall, Leeds 1 (endorsed 'Curator of the City Museums') (September 9).

CHAIR OF ELECTRICAL ENGINEERING—The Acting Registrar, The University, Leeds 2 (September 30).

CHAIR OF BIOLOGY in Victoria University College, Wellington, New Zealand—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (September 30).

LIBRARIAN—The Librarian, Queen's University, Belfast (October 31).

CHAIR OF PSYCHOLOGY in the University of Sydney—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (October 31).

ASSISTANT LECTURER (temporary) IN MATHEMATICS—The Registrar, The University, Sheffield.

ASSISTANT MASTER (Graduate) qualified to teach ENGINEERING SUBJECTS and MATHEMATICS—The Principal, Technical Institute, Beckenham Road, Beckenham, Kent.

TEACHER OF ENGINEERING SUBJECTS (must possess a Degree or equivalent qualification), and a TEACHER (man or woman) OF SCIENCE (with good qualifications in General Science or in Biology)—The Principal, Technical Institute, Darnley Road, Gravesend, Kent.

ENTOMOLOGICAL FIELD OFFICER by the Government of Aden—The Ministry of Labour and National Service, Appointments Department, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. O.S.214).

TEACHER OF ENGINEERING, DRAWING and MECHANICS in the Junior Technical School for Boys—The Principal, Wimbledon Technical College, Gladstone Road, London, S.W.19.

## REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

National Institute of Economic and Social Research. Annual Report, 1943. Pp. 20. (London: National Institute of Economic and Social Research.) [187

British Colliery Owners Research Association and British Coal Utilization Research Association. Report of Discussions on Determination of Particle Size in Sub-Sieve Range. Pp. 69. (London: British Colliery Owners Research Association, and British Coal Utilization Research Association.) [197

Institute of Physics. Report of Institute of Physics and Mathematical Association on the Teaching of Mathematics to Physicists. (London: Institute of Physics.) [197

The Journal of the Institute of Metals. Vol. 69, 1943. Edited by N. B. Vaughan. Pp. xxxvi+526+41 plates. (London: Institute of Metals.) [257

### Other Countries

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 174: Recent Advances in the Prevention and Treatment of Blowfly Strike in Sheep. Supplement to Report No. 2. By the Joint Blowfly Committee. Pp. 20. (Melbourne: Government Printer.) [147

Smithsonian Institution. War Background Studies, No. 18: Peoples of India. By William H. Gilbert, Jr. (Publication 3767.) Pp. iv+86+21 plates. (Washington, D.C.: Smithsonian Institution.) [247

Annals of the Carnegie Museum. Vol. 30, Art. 4: Affinities of *Phoebis rorata* Comstocki, a new Pierid Butterfly from Jamaica. By A. Avinoff. Pp. 45–56+3 plates. (Pittsburgh, Pa.: Carnegie Museum.) [257

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# NATURE

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## CONTENTS




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# MACHINERY FOR INTERNATIONAL ADMINISTRATION

ONE of the factors directing fresh attention to the Civil Service at the present time is the realization that much of the success of our plans for dealing with post-war problems will depend upon the way in which the Civil Service carries out its new duties and discharges the much more positive functions which are being demanded of it to-day. That was wel brought out in the debate in the House of Commons on employment policy, and in the report of the Assheton Committee on the Training of Civil Servants. The machinery of government must be adapted to its new tasks. Some re-tooling may be necessary, and it is at least certain that a large part of the Civil Service will require training for its new functions.

While the machinery of government is being re-examined in this way, the administrative problems of international organization have received comparatively little attention. The effectiveness of any system of world co-operation which may be established will not depend, however, solely on the readiness of the nations to co-operate, and their willingness to ensure that the world organization has adequate force at its disposal. It will depend also on whether the system is administratively sound, not merely in point of theory, but also from the point of view of the men and women who will be called upon to make it work. If it makes demands on their loyalty and integrity that are impossibly severe, the system is doomed to failure as surely as if, for other reasons, it fails to command adequate support.

A modest little study has been issued this year by the Royal Institute of International Affairs which seeks to fill this gap. Under the title "The International Secretariat of the Future", it considers the lessons drawn from experience by a group of former officials of the League of Nations, and indicates concisely the problems which will have to be faced at the administrative level whatever form we may give to the policy-making organ or organs or to the committees advising them, especially in technical matters, in the world organization of to-morrow. It shows clearly how the formulation and execution of policy on an international scale require a machine which is capable of being rapidly extended for special purposes, and of being reduced again, without weakening the machine as a whole, when the special activity is completed. A central and permanent secretariat provides the necessary continuity and accumulation of experience and knowledge; but the equally necessary power of expansion and contraction depends on the collaboration of Governments.

Discussing the main aspects of the work of an international secretariat and emphasizing that such a secretariat must develop to the full the technique of collecting and using material which is not likely to be generally available, but which, as a servant of many Governments, it has unique opportunities of securing, the question first asked is whether twenty years experience shows that efficient international

action on the service plane is possible. Without claiming perfection for the League's administrative machine, the writers submit it has been decisively proved by experience that an international Civil Service need not be hopelessly handicapped by the lack of a sufficient *esprit de corps*, and that the difficulty of mutual understanding, the clash of traditional systems and the inequalities of administrative experience, need not render the machine inefficient. If there is agreement on policy, an efficient international service can be organized to carry it out.

If an international service is properly instructed either to execute a particular decision or to study a particular question, or if it is performing a recognized routine of work, the fact of its being internationally staffed is no handicap to its complete efficiency. The importance of this conclusion scarcely needs to be stressed. It means that in our planning for world peace we can take it for granted that an efficient international administration can be set up to carry out our plans, provided that in this field, just as in the greater field of policy, we are prepared to create and maintain the necessary conditions.

The discussion of what those conditions are occupies the greater part of this report. Dealing first with the general framework, the statement postulates that the future international organization will be based largely on the concept of sovereign States. The immediate international issue will consequently continue to be how to promote better co-operation among sovereign entities, not how to abolish them. Success in voluntary co-operation may lead States gradually to transfer more aspects of their sovereignty to the international organization than they are at present prepared to do.

Secondly, the practical impossibility of separating the problems of peace and welfare into watertight regional compartments postulates, or at least points to, the need for a world-wide organization. The report admits, indeed, the value of regional organization for certain technical purposes, though no reference is made to such functional regional developments as the Anglo-American Caribbean Commission or the Middle East Supply Centre. It is concerned rather with the danger that crystallization on regional lines may create vested interests and thus obstruct further developments, apart from the more insidious dangers of isolationism and the doctrine of the *Herrenvolk* which regionalism might foster. A world-wide system, starting with the United Nations and expanding rapidly to include neutral countries and ultimately the ex-enemy countries, is regarded as the most probable and hopeful form of post-war international organization.

Thirdly, the report assumes that the international organization will cover political, economic, health, transport, labour and other welfare and technical questions with an international aspect. The writers of the report, from their own experience, fully endorse the argument of M. R. C. Greaves in "The League Committees and World Order", and maintain that unless political and welfare interests mutually reinforce each other even more than did the political and technical activities of the League itself and the International Labour Organisation, each is likely to fail of its full effect. They do not advocate, however, the immediate creation of a unitary and highly integrated organization complete in all its parts. Effective organizations for security and international justice must indeed be linked to welfare organizations, and it is obviously advantageous and economical to provide common legal, information, translating and other services for the various agencies. Accordingly, individual functional organizations would tend to become linked sooner or later in a general organization, comprising at least a central secretariat and an annual assembly in which all participating States would be represented. Furthermore, since progress in welfare matters can only be secured if peace is assured, the primary and essential duty of an international organization must be to check any tendency towards aggression, and if need be to prevent aggression by force.

The core of this report is to be found, however, in the following two sections which deal more specifically with the international secretariat itself. In regard to loyalty, it stresses the importance of breadth of outlook. The report quotes C. W. Jenks, legal adviser of the International Labour Office: "The international outlook required of the international civil servant is an awareness made instinctive by habit of the needs, emotions, and prejudices of the people of differently-circumstanced countries, as they are felt and expressed by the peoples concerned, accompanied by a capacity for weighing . . . these elements in a judicial manner before reaching any decision to which they are relevant". It is pointed out that experience shows that a spirit of international loyalty among public servants can be maintained in practice and is an essential factor in the activity of an international service.

Representation (in the diplomatic sense) and defence of national interests should not be the function of secretariat officials, and assurance that an official will not be penalized if his duties involve an attitude which is contrary to the policy of his own country on a particular issue is a natural corollary of demanding international loyalty from the service. This point is of particular importance in view of the recommendations in the recent report on the Training of Civil Servants and elsewhere, that selected officers should be seconded for duties with international bodies as one means of redressing the neglect of the experience of other countries which has characterized the British Civil Service. Officials seconded to an international service are particularly vulnerable in this respect.

There are other sound observations on this question of national representation. A system which depends upon the co-operation of member States cannot ignore the factor of national prestige and interest. Representation of all the member States is desirable in itself, both for the contacts it establishes and because it assuages the legitimate desires of Governments; but it ceases to be so unless each official can be usefully employed. It is an important principle that everybody in the service should have constructive work to do, and this principle must be served even if time is required before the expansion of the service

permits full representation on this basis. Beyond this the career must be made as attractive as possible for able persons, and the usual Civil Service principles of permanence, promotion for merit and pension on retirement must be adopted. Similarly, in interchange of personnel between the international and national services, seconding should favourably affect the individual's career in his own service and involve no diminution of his accumulated rights.

The application of these principles, however, must stop short of the highest posts. It should not be made impossible for an exceptionally qualified member of the service to reach these posts, but fresh recruits and interchange of nationals are here of overriding importance. Appointments to the highest posts should be for a limited period, such as seven years, and renewable only in exceptional cases. These responsible posts will be few in number and will command a high premium. A number of them would be reserved in practice for certain nationalities, but while political considerations cannot be entirely disregarded in making such appointments as the head of the service and his deputy, their effect, if possible, should be limited to the enforcement of a wise compromise between the reasons militating in favour of appointing nationals of major or of smaller powers, respectively, to these and other posts in the higher directorate. Apart from other qualifications, moreover, the high officials must be able and willing to work as a team with those above and below them in the service.

It is not easy to define, the report admits, the qualities which the head of the service should possess. He should be young. Political or diplomatic experience, but not necessarily great fame or eminence, is an advantage. Ability for administration in the broadest sense is important, implying a knowledge of when to be dynamic, to take the initiative and to force an issue; when, at the other extreme, to be content as an administrative official; and when, on a middle course, to be a moderator, impartially smoothing over difficulties. These same considerations will apply largely to other members of the high directorate, and in a new organization the only indispensable qualities of the director may well be common sense, courage, integrity and tact.

The central and essential point is that the head of the service and his staff must win the confidence of the member States, and of the policy-making organs which they may set up. In winning this confidence, the abilities and personal qualities of the officials may be as important as the existence of a proper framework within which to operate. As much care must be exercised in selecting the proper people to run the machine as is exercised in creating it; for if able men are not secured, little advance will be effected in world welfare and security however carefully the machinery be planned.

Among the ancillary problems considered in this report is the work of an information section and relations with the Press; and more detailed suggestions for a secretariat information section are included in an appendix. Understanding and support by world public opinion are as essential to the success of an international organization as the co-operation of member Governments. This is true for technical as well as for political questions, and effective publicity is a vital function of the international secretariat, which can do much to establish the atmosphere in which effective international action is possible. This, as Mr. Greaves notes, was one of the most valuable functions of the technical committees of the League of Nations. Similarly, good administration helps to create the internal atmosphere which is conducive to the loyalty of international officials; it will attract able persons to service in the secretariat, ensure the maintenance of good working relations with the national civil services, and reduce considerably the difficulties of collecting members' contribution quotas.

The Royal Institute of International Affairs has done a real service in publishing this study. Attention is directed to some of the problems which need examination and to some preparatory steps which may have to be taken before any new international organization is established. Some of these problems are intimately related to proposals for the reform of national Civil Services, as in Britain. Above all, the report gives a clear and affirmative answer as to the possibility of an efficient international secretariat if the right conditions are created and maintained, and it points equally emphatically to the way in which the effectiveness of international organization depends not only on the quality of the machinery but also on the will to use it. Success can be attained only if individual men and women exercise, through constitutional processes, ungrudgingly and resolutely, their will to use and support the organization and instruments of world order.

## BIOCHEMICAL CANCER RESEARCH

**The Biochemistry of Malignant Tumors**

By Dr. Kurt Stern and Dr. Robert Willheim. Pp. xiv+951. (London: Macmillan & Co., Ltd., 1943.) 60s. net.

MAINLY because of the practical urgency of arriving at a fuller understanding of one of the most insidious diseases, but also because of the theoretical interest of a problem so closely related to the mysteries of animal growth, cancer research has for many years ceased to be the exclusive concern of the clinician and the morphological pathologist. The methods of biochemistry and experimental biology, in the widest sense of these terms, have been increasingly applied, and these sciences may reasonably claim a large share in some of the most hopeful advances of knowledge which have resulted. At present the major contributions appear to be the chemical carcinogens, the chemistry of tumour growth, the filterable agents of certain fowl and rabbit tumours, and the transmission of mammary cancer in mice by the milk-borne cancer agent: all these owe much to the application of biochemistry. More nebulous at present, but offering glittering prizes for the future, are the similar developments in the immunology and laboratory diagnosis of cancer.

These topics must comprise much of any treatise on the biochemistry of malignancy, and they are all surveyed in the present book. So large is the volume of research on these subjects that they alone could easily fill a book of this size; in fact, it is rather surprising that a symposium of this nature has not been published before. Yet, in addition to these major advances, there exists a vast amount of information about the chemistry of cancer, the significance of which is not yet clear and which cannot at present be fitted into any hypothesis concerning the origin and nature of neoplasia. It must regretfully be admitted that there is also a legacy of many years research, much of which is under the grave suspicion of being completely uncritical and technically unreliable.

The scope of the present book is ambitious, in that it attempts to cover the entire field of biochemical investigations connected with the cancer problem in all its aspects. This is a formidable undertaking, and although the result will scarcely satisfy the specialist in any one branch of cancer research, for whom something on the lines of a symposium seems more or less necessary, the authors fully deserve warm commendation for what is undoubtedly a valuable addition to the literature of cancer. The book is all the more welcome since no such compilation in English was hitherto available.

A word about the origin of the present volume may not be out of place. It is based on the extended text of an earlier (1936) German edition by the same authors, both of whom are known for their work in the University of Vienna upon the so-called 'carcinolytic' reaction of Freund and Kaminer. The fact that this reaction is by no means in general favour nowadays need not prejudice the reader against the book, since it is not at all propagandist for any one theory, and the balance of judgment is fairly held throughout; this particular theory not excepted. The present version covers the literature up to the end of 1941 and partially into 1942; the modernization is the work of Dr. Stern, who, in New York, was unfortunately deprived after 1941 of communication with his co-author in the Philippines. To avoid confusion, it may be pointed out that this Dr. Kurt Stern should be distinguished from Dr. Kurt G. Stern, until recently of Yale University, who has also contributed to the biochemistry of cancer.

The classification of the greater part of this book follows the conventional approach of a text-book of biochemistry, although it will be understood that its scope, presentation, and bibliography make it essentially a reference work. This is illustrated by the references to original publications, which appear as footnotes to each page and number from 250 to about 1,000 per chapter. Those that the reviewer has had occasion to consult were all correctly cited. The headings of the chapters indicate the wide variety of topics: inorganic, organic, and physical chemistry; enzymes; nutrition and vitamins; metabolism; hormones. In addition, three highly interesting chapters cover the relevant biochemical features of immunology, chemical and biological tumour diagnostics, and the biochemical aspects of tumour origin and growth. In every subject the treatment is exhaustive, and although not every paper of importance is quoted, nor could this be expected, the omissions are remarkably few, and in almost all fields a very comprehensive picture is presented. It is probably true to say that even the experienced cancer research worker will find many interesting observations recorded here that are unfamiliar to him, or the existence of which he had forgotten. Reference to the excellent subject index will confirm this opinion.

In such a careful and thorough compilation it is a pity that the writing and editing call for some criticism. It should have been a simple matter to eliminate the rather frequent occurrence of un-English phrases, and there is an almost complete absence of sub-headings; for example, the important section on tar and the carcinogenic hydrocarbons as carcinogens occupies thirty pages of solid text without subdivision, in spite of the wide range of topics embraced.

This latter section is perhaps too highly compressed, since it deals with what is undoubtedly an outstanding achievement of cancer research; and the description of the biochemical effects of radium and X-radiation is also very much curtailed. The authors themselves recognize this, and refer the reader in both instances to published reviews. While I sympathize with the difficulty of summarizing what has already been so brilliantly recounted by the original discoverers of the synthetic carcinogenic agents (Kennaway, Cook and collaborators; *Amer. J. Cancer*, **29**, 219–259 (1937); **33**, 50–97 (1938); **39**, 381–582 (1940)), I consider that the balance of the book has been affected by this disproportionately short account. Space for a fuller discussion might perhaps be found by the elimination from other chapters of a number of very dubious earlier references, the claim of which even to historical interest is questionable. In this chapter it is erroneously stated that 1 : 2 : 5 : 6-dibenzanthracene is excreted by the rabbit as the 4′ : 8′-dihydroxy derivative, but not by the rat or mouse (p. 179); in fact, the latter species excrete this derivative, while an unidentified isomeric dihydroxy compound is eliminated in the rabbit. This prompts the suggestion that in general works of this kind the authors would do well to insert the key numbering of the carbon atoms in their published formulæ of polycyclic compounds; otherwise such descriptive names in the text mean little to any but the specialist. In this book, also, formulæ for the carcinogenic azo-dyestuffs might with advantage be included.

The descriptions of the mechanism of carbohydrate metabolism given in Chapter 6 need revising and bringing up to date, and I am not aware of the observation (incorrectly stated to be contained in reference No. 195 on p. 507) that the aerobic glycolysis of chorio(n)epithelioma is abolished when serum is used as the suspension-medium; if true, this would be unique among malignant neoplasms, and as it is this kind of statement that is copied from book to book, it should be correctly quoted. Is it possible that the authors have confused the terms chorionic epithelium and chorion-epithelioma? In any future edition it would be well to emphasize more strongly the loss of specialized metabolic function which accompanies the loss of morphological differentiation in malignant tumours (cf. Dickens and Weil-Malherbe; *Cancer Research*, **3**, 73; 1943).

Perhaps the general recognition of the multiplicity of carcinogenic stimuli is the most characteristic feature of the present stage of cancer research. The problem that still awaits solution is that of correlating these diverse phenomena. Thus, the occurrence of spontaneous mammary cancer in mice is now generally admitted to be determined by at least four distinct factors: the influence of the maternal milk-borne factor, the genetic constitution of the strain, the quantitative and qualitative composition of the diet,

and the effect of hormones, especially the sex hormones. The incidence of breast cancer may be varied almost from zero to 100 per cent by suitable known variations in these factors. On the other hand, in the case of the chemical carcinogens, the effects of the milk factor, hormones, and even genetics appear to be relatively unimportant. The explanation of this apparent paradox, which might perhaps provide a much-needed link between the chemically induced and spontaneous tumours, is an outstanding problem. The claims that filterable tumours can be obtained in fowls by the action of chemical carcinogens lead one to ask if even the milk-borne cancer factor might not also be induced by chemical carcinogens to appear in a strain of mice where its presence cannot normally be demonstrated. No doubt this question will soon be answered, if indeed the experiment has not already been done. The important point is, however, that the progress of the last two decades has made it possible to ask, and to answer, many such questions.

F. DICKENS.

## HIGHER EDUCATION IN ENGLISH-SPEAKING COUNTRIES

**Educational Yearbook of the International Institute of Teachers College, Columbia University, 1943**
Edited by Prof. I. L. Kandel. Pp. xi+297. (New York: Teachers College, Columbia University, 1943.) 3.70 dollars.

THE Educational Yearbook of the International Institute of Teachers College, Columbia University, came into existence twenty years ago, during the whole of which time it has been under the able editorship of Prof. Kandel. The 1943 issue is devoted to higher education in English-speaking countries. At the moment, higher education in all countries is, of course, thoroughly subordinated to the urgent task of winning the War. Nothing else matters. What are usually called the humanities are in a state of suspended animation, and the scientific studies are pursued for utilitarian ends. But in the period following the War, the immediate future of higher education will certainly be one of the most important problems of educational reconstruction. In every country certain questions will inevitably arise. For how many students should higher education be made available ? In what relation does higher education stand to the demands of the modern world ? How can we develop a proper balance between the humanities and the sciences ? What are the relative places of general education and specialization, and what is the relative importance of teaching and research ? Already these questions are being discussed sporadically in magazines and newspapers, both in England and in the United States. This educational yearbook widens the outlook by extending the discussion to all English-speaking countries.

The chapters are placed in alphabetical order, beginning with Australia and ending with the United States of America. As no question of continuity arises, the chapters may be read in any order. Four are assigned to England, six to the United States, and one apiece to Scotland, Ireland, Canada, Australia, New Zealand, South Africa and India. One can well understand the editor's difficulty in enlisting the services of an adequate team of contributors, literally from the ends of the earth, and under war-time conditions. One proof of his success is that most of the chapters are marked by a catholicity of view which sees educational reform in its broad social, and sometimes political, setting. Some of the chapters are interesting and informing as much for the light they throw upon the general situation as for the special purpose for which they are written.

The selected countries present such diversity that no brief summary is possible. In the case of England, the obvious contrast, between Oxford and Cambridge on one hand, and the newer civic universities on the other, raises problems as yet unsolved. It is noteworthy that science has recently made great headway in both the older universities. London stands, as it always has, for religious equality, and it fairly claims to be the first university to admit women to degrees, and the first to give science its due. The chapter on the provincial universities of Britain is one of the most interesting in the book. The Scottish universities, strong in the affections of all classes of the population, present few puzzles to the expositor. Quite the contrary is the case of Ireland, where university education has been complicated from the start by political and religious differences, raising difficulties which have only gradually and as yet partially been overcome.

As for the United States, the general situation at present seems well described by one of the six contributors, who says that the colleges have become armed camps. The journal usually known as *School Life* is replaced by *Education for Victory*; and if this indication is true of the schools, it is certainly true of the colleges and universities. The contributors are quite the reverse of complacent, and post-war reforms are keenly advocated.

In Canada the tendency to educate children in the high schools as if they were all proceeding to universities is being corrected, and the high-school graduate is being "better fitted to meet the demands of modern life". But the outstanding point is that educationally there are two Canadas, representing the British and the French traditions. One of the challenges to the future is that a greater integration be achieved, and "all thoughtful Canadians will agree that, unless the challenge be met, Canadian unity will not be achieved". The report on Australia has many cheering features, but the universities are said to be so "sadly departmentalized" that students who may be trained efficiently for medicine, law, or engineering have no training as citizens, and no interest in the social implications of their professional activities. New Zealand has emerged from the callow stage of reliance upon external examinations conducted from England, but her universities need also to realize the inescapable duty of equipping their students to deal, both as professional workers and as citizens, with the problems of the new world.

A far more tangled problem is that of the Union of South Africa, with its 2,220,000 whites (of whom 60 per cent are Africaners, 35 per cent British and 5 per cent others, mostly Jewish), its 750,000 half-breeds, its 250,000 Indians and its 6,000,000 Africans —fundamental divisions which are reflected in the universities and colleges. Whether Africaner or English in character, the universities are said to remain "the organs of a dominant white group content with the place which it has built for itself at the top of the Union's racial-caste structure". There remains for comment gigantic India, "English-speaking" in the sense that a century ago it was decided that English should be the medium of instruction

in higher education. The dark cloud hanging over the system is the fact of thousands of young men with a university education who are unable to find suitable employment. Signs of a change are, however, discernible. "The old superstition that practical studies were not quite respectable and that technical training was a relatively low type of education is beginning to disappear." The work of the universities needs to be more fully directed to the many problems, human and material, with which the country is faced.

The survey brought together in this modest volume of three hundred pages presents an almost bewildering variety of conditions, and the actual work of the universities and colleges cannot be the same in all the countries included in the survey. One is left in no doubt as to the enormous influence, not always for unmixed good, which places of higher education exert upon a nation's life. The one deep impression which these records leave upon the reader's mind is that in the post-war world the universities must shun the evil of the narrow outlook. When the ancient and the modern, the cultural and the vocational, the humanistic and the scientific, the liberal and the utilitarian, stand rigidly apart, each secretly or openly despising the other, then the fatal narrowness, quite consistent with the utmost dignity and respectability, appears. Always and everywhere, the business of the university is "the education of the whole man".

T. RAYMONT.

## A SYNOPSIS OF INDIA

**India in Outline**

By Lady Hartog. Pp. xiii+110+31 plates. (Cambridge: At the University Press, 1944.) 6s. net.

FOR a general conspectus of India as it is, in most of its aspects, and all comprised in one hundred pages, it would be difficult to find an equal to this little book by Lady Hartog. Its eleven chapters deal with geography and climate, custom and culture, history ancient and modern, the Indian States, natural resources and revenue, industry, administration (including education, public health, etc.), politics, the army, and India's part in the War. There are an appendix consisting of half a dozen compact tables from the 1941 census, a short bibliography, an index, a map, and thirty good photographs well reproduced.

With a scope of this breadth the treatment must be sketchy in the extreme, but the sketch is unbiased, is drawn in admirable proportion, and is surprisingly comprehensive. Inevitably occasional general statements are made which are open to contention. They would no doubt be qualified if there were room for more detailed treatment. One may legitimately doubt whether *purdah* was really introduced by Muslims; or whether the population of India north of the Vindhyas is anything like so distinct from that south of it as Lady Hartog would suggest, for though it is true that purely linguistic differences support her view, anthropological ones are less in her favour. The description of the *ryotwari* system of land tenure as found mainly in the south is scarcely accurate; a *zemindari* system prevails in much of the United Provinces, Bihar and Bengal, but not in the Punjab or Assam. The statement that the cost of the army absorbed about a quarter of the total pre-war revenues of the Government of India is apt to prove misleading to anyone unfamiliar with the division of financial responsibilities between the local and central governments in India. Shellac does not seem to be mentioned among the important commercial products.

The bibliography is disproportionately inclined to the political aspect; short as it is, it might well have included Macdonell's "India's Past" and Blackham's "Incomparable India", while *Great Britain and the East* might perhaps be added to the list of periodicals.

But the fact that there seems little more than that to be said in criticism is in itself high praise. No other outline exists nearly so good to put in the hands of persons ignorant of India and wanting information of every kind in a compact and easily ingested form. Even those who have known India well in pre-war years, but not since war broke out, may learn much from the chapters on India and the War, which bring out well both the remarkable advance which has been made in industry and the narrowness of the margin of India's food supply. In a concise general account of this kind it is far harder to keep due proportion and perspective than on a wider canvas, and the author deserves every credit for an admirable sketch.

J. H. HUTTON.

## PHYSICS AND PHILOSOPHY

**Proceedings of the Aristotelian Society**

New Series, Vol. 43: Containing the Papers read before the Society during the Sixty-fourth Session, 1942–1943. Pp. xxvi+222. (London: Harrison and Sons, Ltd., 1943.) 25s. net.

THIS volume contains, among papers on a wide range of subjects, a symposium on "The New Physics and Metaphysical Materialism" in which the late Prof. Susan Stebbing, Sir James Jeans, Mr. R. B. Braithwaite and Prof. E. T. Whittaker took part (see *Nature*, June 19, 1943, p. 686). Prof. Stebbing in her life-time was convinced that Eddington and Jeans used their standing as scientific men to put across to the public metaphysical views which were thoroughly unsound. In her contribution to this symposium she argues that "the new physics does not imply idealism" (p. 184). If Sir James Jeans thinks it does, it is because he argues, erroneously, that because the wave-picture of the universe is essentially mental, the universe it pictures must be so also.

In answering Prof. Stebbing, Sir James Jeans is led to develop a metaphysic of objective idealism not unlike Spinozism. The particle-picture and the wave-picture both depict reality; one is material, the other mental in its ingredients; therefore reality has a material and a mental aspect.

Mr. Braithwaite out-Stebbings Stebbing in maintaining that the new physics has no relevance for metaphysics. As an exercise in philosophy his paper is the best of the four, but as criticism of Sir James Jeans it is wide of the mark, and what Prof. Whittaker says of Miss Stebbing's contribution would apply equally well to that of Mr. Braithwaite: "It has all the merits and perhaps some of the defects that one would expect to find, say, in a commentary on some of the more mystical poems of Wordsworth by Mr. Bertrand Russell". We may expect this state of affairs to continue until "physicists are philosophers and philosophers physicists".

WINSTON H. F. BARNES.

# THE LIQUID STATE

THE twenty-eighth Guthrie Lecture of the Physical Society was delivered last April by Dr. J. H. Hildebrand, professor of inorganic chemistry in the University of California. He had chosen for his subject "The Liquid State". Prof. Hildebrand is one of the greatest authorities on the physical and chemical properties of solutions, and it is only natural that his vast knowledge and experience in this field have enabled him to tackle the difficult problem of the constitution of liquids on new and promising lines.

Prof. Hildebrand began by outlining and discussing the two conventional methods by which the problem is usually approached: the analogies to the gaseous and to the solid state. A liquid resembles to some extent a compressed gas, and the theoretical treatment of such a model has the van der Waals equation as its basis. However, when we compare the terms of the van der Waals equation with their counterparts in a purely thermodynamic equation of state, we find that it is not possible to fit them with the same constants over any considerable range in the case of liquids. It is, of course, possible to correct the equation by additional constants, but this does not bring us nearer to the desired theoretical interpretation. The customary analogy between the behaviour of gases and liquids as represented by van't Hoff's law for osmotic pressure leads to impossible consequences when concentrated solutions are considered. Instead of describing a liquid as a compressed gas, it can be treated—starting from the other extreme—as a very disordered solid, that is, as a crystal lattice which has been disturbed by the process of melting. This method has been helped to a great extent by the considerable amount of information on the structure of solids at our disposal, and it is a line of approach which offers good prospects for a theoretical interpretation of the liquid state.

Quite a different line of approach can, however, be developed by using a method of interpretation which arises out of the experimental study with the aid of X-rays, and it is on considerations of this kind that Prof. Hildebrand has based his views on the constitution of liquids. The scatter of X-rays in a liquid does not suggest a state of order in any way like that exhibited by a crystal lattice. Its interpretation reveals a short-range order which can be best represented by plotting the average number of molecular centres to be found in the neighbourhood of any given molecule against the distance from this molecule. The number of molecular centres contained in a spherical shell which surrounds the central molecule is given by the volume of the shell, multiplied by the number of molecular centres per unit volume of the substance. This estimate takes no account of the space required by the individual molecules, in so far as it clearly cannot be true for a shell of the order of magnitude of the minimum distance to which two molecules can approach. We must, therefore, introduce a correcting factor which varies with the distance from the central molecule and represents the structure of the liquid. This 'distribution function', $W$, is zero for any distance smaller than the molecular diameter. Beyond this distance we meet the first layer of surrounding molecules and $W$ will be greater than unity. Between the first and the second layer of surrounding molecules, $W$ shows a minimum, rising to a second maximum at the distance of the second surrounding layer. The success of this approach to a general interpretation of the structure

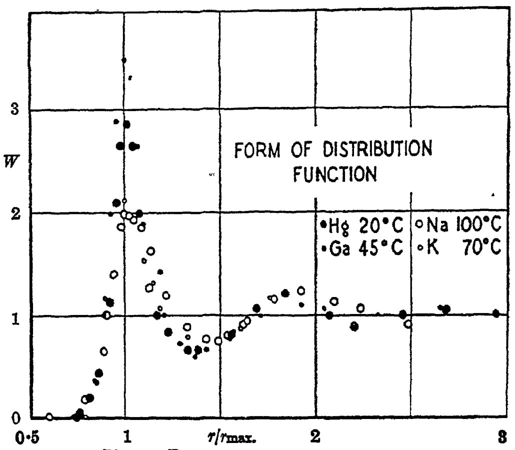


Fig. 1. FORM OF DISTRIBUTION FUNCTION.

of liquids can be gathered from Fig. 1, which shows the distribution function for a number of liquid metals at corresponding states. Here $W$ is plotted against $r/r_{max.}$, where $r_{max.}$ is the position of the first maximum. The figure emphasizes the short range of order encountered in liquids, $W$ remaining practically 1 for distances greater than the radius of the second surrounding shell of particles.

The full significance of this treatment becomes apparent when we consider the forms which $W$ assumes in a solid and in a gas. In the latter case, $W$ rises from zero for distances smaller than that given by the closest approach at collision to the value of 1, which is maintained for all greater distances. In the solid, the long-range order is represented in $W$ by a succession of tall, narrow bands which occur at distances where new groups of molecules will be found. The temperature dependency of the structure becomes apparent by a widening of these bands

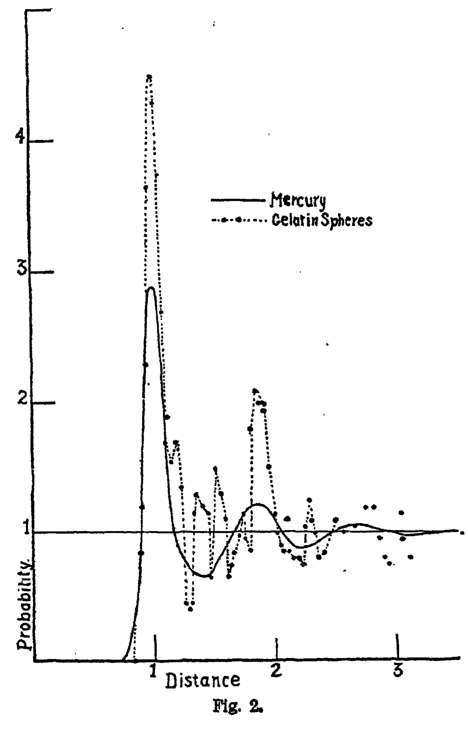


Fig. 2.

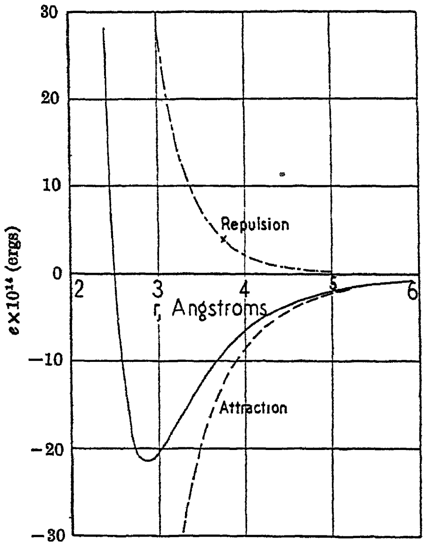


Fig. 3.

caused by the increasing amplitude of vibration of the molecular centres around the lattice points. At the melting-point the bands merge into the 'liquid' curve. With further rise in temperature the state of order in the liquid decreases progressively, the liquid curve flattens more and more, until finally $W$ is unity for any distance larger than the molecular diameter; the gaseous state has been reached. Prof. Hildebrand mentioned an ingenious demonstration experiment on a mechanical model of a liquid which had been carried out at his laboratory. The place of the molecules was taken by a number of gelatine spheres which were inserted in a cubical container, filled with a gelatine solution of the same refractive index as that of the spheres. This made the spheres invisible except for a few which had been coloured. The container was shaken, and the position of the coloured spheres determined by spark photographs. The $W$-function for this system was calculated from the results of these photographs and is reproduced in Fig. 2. For comparison the $W$ function for mercury is superposed.

By combining the known values of the heat of vaporization at different temperatures with the $W$ function, the potential between a pair of molecules of the liquid can be obtained. Splitting the potential into an attractive term $k/r^6$ and a repulsive potential $j/r^n$, the values for $k$, $j$ and $n$ can be found and the potential function constructed. This has actually been done from X-ray results for mercury and the function obtained is given in Fig. 3. A test for the legitimacy of the method was provided by an independent calculation of $k$, which came to $3 \cdot 35 \times 10^{-10}$, a value which is in excellent agreement with that of $3 \cdot 52 \times 10^{-10}$ from the computation based on the $W$-function.

So far, only molecules have been considered which exhibit spherical symmetry in shape as well as in the field of force. There exists an equal maximum state of disorder in all liquids which are composed of spherical molecules, and on passing into the gaseous state they all must suffer the same increase in entropy on evaporation. This is simply Trouton's rule, which holds for all 'normal liquids', and which states that they all have equal entropies of vaporization at the boiling point, or, as Prof. Hildebrand would rather say, at the temperature where the molal volumes of vapour are equal. If, on the other hand, we deal with liquids the molecules of which are very elongated or contain dipoles, we can expect a certain degree of order in the spatial arrangement of these molecules, and the entropy of such liquids will be smaller than that of the completely disordered normal liquids. Since the entropies of all vapours under corresponding conditions are equal, the entropy of vaporization of liquids with non-spherical molecules will be greater than of normal ones. The significance of these exceptions from Trouton's rule is exemplified by the following table, in which the entropy of vaporization at equal molal vapour volumes ($\log R/V = 0 \cdot 1$) is given for a number of liquids.

| Liquid | $\Delta S$ | $\Delta S - 20 \cdot 1$ |
|---|---|---|
| Mercury | 20·1 | 0·0 |
| $C(CH_3)_4$ | 20·1 | 0·0 |
| $i$-$C_5H_{12}$ | 20·2 | 0·1 |
| $n$-$C_5H_{12}$ | 20·7 | 0·6 |
| $n$-$C_6H_{14}$ | 21·5 | 1·4 |
| $(CH_3)_2CH.CH(CH_3)_2$ | 20·3 | 0·2 |
| $CHCl_3$ | 21·7 | 1·6 |
| $(C_2H_5)_2O$ | 21·8 | 1·7 |
| $(CH_3)_2CO$ | 22·5 | 2·4 |
| $C_2H_5OH$ | 27·0 | 6·9 |
| $CH_3OH$ | 26·5 | 6·4 |
| $CCl_4$ | 20·7 | 0·6 |
| $SnCl_4$ | 21·8 | 1·7 |
| $C(NO_2)_4$ | 22·6 | 2·5 |

The second column, giving the differences between the vaporization entropies of the various liquids and that of mercury, denotes their state of order compared with the maximum disorder for spherical molecules. The degree of order which is introduced by alterations in the shape of the molecule is apparent in the differences between the pentanes, between di-*iso*propyl and normal hexane, and finally in the series carbon tetrachloride, stannic chloride and tetra-nitromethane. The deviations from Trouton's rule shown by chloroform, ether and acetone are due to the existence of a strong dipole in the molecule, and to the order created by the mutual interaction of these dipoles in the liquid. It is interesting to see that, though they all have dipole moments of roughly equal strength, the state of order in acetone is considerably greater than in the other two. The explanation is that the dipole in acetone is not buried inside the molecule as in chloroform and ether. The most striking exception, however, is that of the alcohols, and it seems difficult to account for this large deviation by either of the explanations. More information on this point can be gained by dissolving these dipole molecules in non-polar solvents and by observing the change in polarization with concentration. The very strong rise with increasing concentration in the case of the alcohols suggests that the high degree of order in the pure liquid is probably due to the formation of hydrogen bridges.

This is just one example in which the study of solutions aids in the interpretation of the general problem of the constitution of liquids. Thus we can combine observations of the composition of solutions with observations of the vapour phase, which leads us to consider deviations from Raoult's law. This rule states that for a great number of solutions, ideal solutions as they are called, the partial vapour pressure of each component is simply given by the product of its vapour pressure in the pure state and its molar fraction in the solution. Reverting to a description in terms of molecular characteristics, it

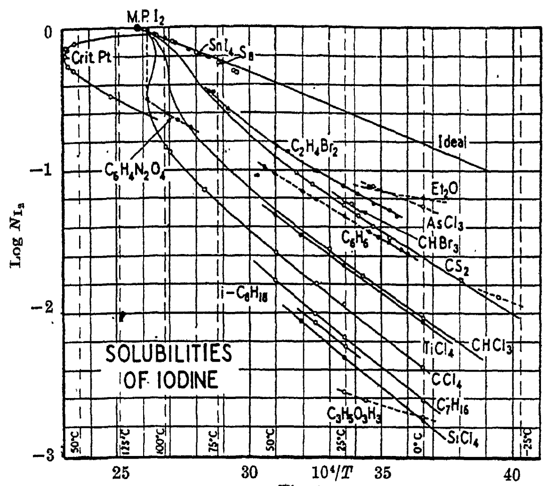


Fig. 4.

means that Raoult's law will hold for mixtures of the same species of molecule, that is, for molecules of equal size, shape and field of force. We can vary this condition by mixing different species and comparing the partial pressures. An interesting case is a mixture of molecules of equal field-strength, but of different size. Here the conceptions of the osmotic school, expressing concentrations in moles per litre, break down. According to these conceptions, we should expect, for example, ethane under one atmosphere to dissolve to the same extent in a given volume of any higher paraffin. On the other hand, the mole fraction of a given amount of ethane in dodecane would be twice that in the same volume of hexane. To achieve the same solubility the pressure of ethane over dodecane would have to be doubled. It is the latter alternative that is supported by the experiment. Normal paraffins of different length such as butane and heptane obey Raoult's law. It simply means that only the space between the molecules of the solvent is at the disposal of the second component, and not the total volume.

The properties of solutions offer almost unlimited scope for obtaining information on the problems of the liquid state. The same considerations as applied to the evaluation of the potential between a pair of identical molecules can be employed in evaluating potentials between molecules of different kind. If we have spherical molecules of equal size, but different molecular fields, the $W$-function is the same as in the pure liquid and can be made the base of calculations. Of the great number of examples given by Prof. Hildebrand, the set dealing with a comparison of different solvents for iodine is perhaps the most instructive one. The solubilities for this substance are given in Fig. 4. Most of the curves belong to one family; they represent 'regular solutions' for which computation on the lines indicated above is possible. They all show the violet colour of iodine vapour, which indicates that the iodine molecules are simply dissolved and have not taken part in chemical changes. The solutions corresponding to the non-regular curves, on the other hand, have different colours and make one suspect that chemical changes have occurred. Prof. Hildebrand directed special attention to the loop intersecting the curve for carbon tetrachloride. Calculation shows that the curve running through the points for the solubility of solid iodine must exhibit an S-shape; which means that there are two compositions in equilibrium at the same temperature. Experiments which had to overcome the difficulty that iodine solutions of such high concentration are quite opaque gave the complete liquid–liquid solubility curve in close approximation with the calculated values.

Results such as this show how far theoretical interpretation of the liquid state can provide an explanation of the observed phenomena, and can even be used in the prediction of conditions of considerable complexity. In his conclusion, Prof. Hildebrand left no doubt, however, that while there are remarkable achievements already at hand, the liquid state still abounds in unexplained phenomena which await elucidation when scientific men can return to its problems after the War.

K. MENDELSSOHN.

# NUTRITION AND A MATTER OF TASTE

By DR. MAGNUS PYKE

DURING the past twenty-five or thirty years the science of nutrition has made very great strides. These advances have been due almost entirely to the application of precise, objective, chemical methods, and have been paralleled by similar advances in other branches of biology. Those who study endocrine secretions can determine, according to his endocrine balance, how the character of a man will be influenced. Similarly, the nutritionist can say from an analysis of the foodstuffs of which a man makes up his diet whether or not, and in what way, his body will be influenced for good or evil. By these means it is now possible to decide, to a greater or less degree of precision, the physiological needs of such divers individuals as pregnant women, adolescent children or coal-miners for calories, protein, fat, four or five mineral substances and six or seven vitamins. In making these advances in knowledge, the subjective feelings of the individuals concerned have not only been neglected; they have specifically been excluded. This has led to several curious conclusions, two at least of which may be cited.

There is, for example, no scientific evidence to suggest that violent muscular work has any influence whatever on the physiological demands of an individual for animal protein; yet there is a widespread popular belief that meat is essential for the efficient prosecution of manual labour. Similarly, so far as the classical nutritionist is aware, onions, garlic and pickles are of negligible nutritional value. Nevertheless, so pressing is the popular demand for such condiments that Britain, faced with extreme pressure on her land for food and aerodromes, is compelled to devote a substantial acreage to their culture.

Now, into the traditional, generation-old field of respectable nutrition comes Prof. Curt Richter, of the Johns Hopkins University School of Medicine*, with a summary of a number of inconvenient papers which have been appearing in the physiological literature during the last ten years, and the implications of which have largely been ignored by nutritionists.

Prof. Richter begins quietly. If rats are kept in a cage on a salt-free diet and given the opportunity of drinking a 3 per cent salt solution out of a graduated tube they will, on the average, drink enough of the

* "Total Self-regulatory Functions in Animals and Human Beings." Curt P. Richter. The Harvey Lectures Series, 38, 63 (1942–43).

solution to provide for their nutritional needs. If the animals are then adrenalectomized, the consumption of the solution of sodium chloride increases enormously even if other solutions are made available. If, on the other hand, the calcium metabolism of rats is disturbed by parathyroidectomy, their appetite for solutions of calcium salts increases and also their desire for salts of chemically related metals such as strontium and magnesium, but not for any other substances.

The next stage of the work was clearly to divide the animals' diet into all its constituent nutrients, and this Prof. Richter did. The rats were placed in cages equipped with several food cups containing, separately, weighed amounts of purified carbohydrate, protein, fat and such materials as dried yeast. Furthermore, they were confronted with from eight to twenty graduated tubes containing measured amounts of solutions of sodium chloride, potassium chloride, calcium lactate, sodium phosphate, magnesium chloride, aneurin, riboflavin, nicotinamide, calcium pantothenate, choline chloride, pyridoxin hydrochloride, biotin, cod-liver oil and any other of the substances it was desired to test.

Some of the results were of surprising interest. For example, when presented with this plethora of choice among substances never normally encountered pure in Nature, and many of which are devoid of any definite taste or smell, not only did the rats choose for themselves a perfect diet, according to the most up-to-date nutritional knowledge, but also they made on their self-chosen diet more economical growth than on a stock diet of non-purified foods. When the rats were depancreatized, they spontaneously avoided carbohydrate and maintained their calories with fat. When the bottle containing aneurin, which is specifically concerned with the intermediary metabolism of non-fat calories, was taken away, the rats reduced their consumption of non-fat calories and ate more fat. When given aneurin but deprived of riboflavin, nicotinamide and pyridoxin, the animals ate more carbohydrate, some fat but almost no protein, thus suggesting that one or other of these vitamins is specifically concerned with intermediary protein metabolism.

Further interesting results were obtained by following the diet which was spontaneously chosen by female rats during the course of pregnancy and lactation. As might, perhaps, have been expected, the calcium consumption rose only slightly during pregnancy but increased very markedly during lactation. An unexpected finding was, however, that the sodium chloride intake increased during pregnancy, and increased again even more substantially during lactation.

What is the application of this line of approach to problems of human diets ? Man has survived for some few thousand years on a self-chosen diet so that, presumably, even without the benefits of academic qualifications in nutrition, he must apparently possess certain powers of discriminating what is good for him. But one has only to look at the physique of the population of a London underground station during an air raid, or notice the enormous incidence of defective teeth among the bulk of even the younger members of the British industrial population, to realize that *laisser-faire* in human nutrition is not enough. Prof. Richter's rats can practise self-selection in their diets when each nutrient is separated from the other. Sir Jack Drummond, on June 27 from the chair of the Nutrition Panel meeting of the Food Group, Society of Chemical Industry, at Burlington House, commented that workmen, who could be demonstrated clinically and biochemically to be deficient in vitamin C, would yet refuse a salad from the best intentioned British *restaurateur*. The explanation may be that if these men had the freedom of choice of the rats, they would select more fat and perhaps sugar than they were getting. Their physiological urge was more likely to be for calories, which, however much vitamin C it might contain, salad signally fails to supply.

Prof. H. Hartridge, at the same meeting, suggested that, fundamentally, the special senses—taste, smell and the others—gave the brain a quick analysis of the blood. If the salt concentration was low there was a craving for salt; if the protein concentration was low, might there not be a craving for, say, meat ? This perhaps was more speculative. These special senses also served to give warnings. On this point, Richter has an interesting experiment to quote. Some of his rats were given the opportunity of drinking their water equally and indiscriminately out of two graduated bottles. To the water in one bottle, very small but increasing concentrations of mercuric chloride were added day by day. When the amount reached 0·003 per cent, which was far too little to exert any physiological effect, the rats suddenly stopped taking the solution from the poison bottle.

Dr. D. R. Davis, of the Psychological Laboratory, Cambridge, also had some interesting comments to make. For example, rats can maintain their calorie needs on solutions of sugar, alcohol and water. When the sugar solution was exchanged for a similar-tasting solution of saccharine, the animals maintained an equal calorie intake by increasing their consumption of alcohol.

Dr. Davis went on to show, however, some of the reasons why whatever biochemical powers of selection man may possess are not sufficient to enable him to dispense with his objective knowledge of nutrition. The first point is 'habituation'. Rats can get used to eating out of a pot placed in a special position and will then fail to select more nutritious food placed in an unfamiliar part of the cage. Animals get 'accustomed' to certain meal-times. Pavlov's experiments with dogs and dinner bells were mentioned here. There was also some discussion of diurnal metabolic variations; but the meeting of the Nutrition Panel seemed quite incapable of coming to any reasonable conclusions about the best meal-times for people working on awkwardly arranged shifts. The palatability of 'appropriate' food was mentioned. To a Briton, sour milk is nasty, and cream-cheese nice; putrid chicken is bad, but putrid pheasant good. Finally, there was the point that people taste with organs other than their mouth and nose. Not only can a blindfolded man not distinguish between a two-penny cigar and a three-shilling one; he rarely knows whether either is alight or not. Dr. Davis cited the example of two chocolates of identical taste and consistency but one white and the other brown. These were rated equally during blindfold tests, but when the examiners could see, they thought the white one 'fatty', 'tallowy' and generally inferior.

Dr. G. W. Scott-Blair showed how many of the ancillary sensations, such as firmness, 'liveliness' and 'body', which combine together with taste to give an individual ideas as to whether or not he likes a food, can be measured mathematically. That the mathematical functions are complicated is, apparently, no

deterrent to the subjective influence on people assessing food. Indeed, they are prepared to compare mathematically incomparable quantities, and provided that they are young and unbiased can, apparently, consistently measure viscosity in terms of elasticity.

But whereas Dr. Scott-Blair tried to explain to a slightly mystified audience of chemists at the Nutrition Panel meeting how to measure in mathematical quantities senses, about which Prof. Hartridge as a physiologist and Dr. Davis as a psychologist had spoken, Mr. R. R. Plowman, an expert and experienced tea-taster, showed how the senses of smell, taste, sight, touch and temperature can, in actual practice, all elegantly be combined.

Evidence which has been accumulating in the literature and much of which was summarized at this meeting of the Nutrition Panel now suggests that the special senses of taste and the rest offer, if used with proper precaution, a fruitful and new method for nutritional research. Richter quotes at least two interesting experiments with human subjects. The first concerns a 3½-year-old boy with undiagnosed destruction of the adrenal cortex. This child kept himself alive for more than two years by eating handfuls of salt. When he was taken under control and fed a 'proper' hospital diet he died. The second experiment is of more general application. A graph was made of the percentage of children between the ages of 5 and 14 years who liked a test sample of cod-liver oil. In general, the frequency decreased as the age increased and as the known physiological needs diminished. The precautions to be exercised when trying to carry out experiments of this nature are many and obvious. Habituation, learnt custom, suggestion, whether visual or of any other kind, are a few. Certain tastes may be exceptional to the rule, if rule it is, that animals, if given the opportunity, will choose the nutrients they need. For example, the nutritionist hitherto has been nonplussed by onions, garlic and perhaps sweetness. Furthermore, people eat food, not nutrients. Nevertheless, it has often been a safe rule when studying industrial nutrition to start from the traditional dietary pattern and try to improve on that, rather than impose a theoretical regime.

The science of nutrition has progressed a long way. It certainly has still a long way to go. Perhaps this meeting of the Nutrition Panel, where nutritionists, chemists, physiologists, psychologists and those forgotten folk who taste and choose and cannot explain, all met to talk together and partially to comprehend each other, may have served in some small way to send it off on a new, fruitful journey.

# THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE IN WAR-TIME

By Prof. C. W. WARDLAW
University of Manchester

ONCE established, the continuity of British institutions tends to be maintained no matter what the impact of external circumstances may be. In the gloomiest periods of the years 1940–42 it was a feature of life in Britain that bodies concerned with matters of cultural interest were not merely kept in being but in some instances even acquired a new vitality. The publication of the report of the Governing Body of the Imperial College of Tropical Agriculture, Trinidad, for the year 1943, serves to remind us of yet another instance of this continuity of the national effort in the arts of peace, this time in spheres remote from the European conflict—a continuity all the more remarkable in view of the difficulties that lie in the way.

Readers may perhaps recall that the Imperial College of Tropical Agriculture was founded to provide higher instruction in tropical agriculture and in the cultivation and preparation for market of tropical produce of every kind. Practically all members of the Colonial Agricultural Service pass through the College as a first stage, or otherwise have associations with it; thus the bonds that unite past students confer an almost unique unity and coherence to the collective personnel of this Service.

That an effort to maintain the College and its work should be made is not surprising. The developments and improvements that must be effected in agriculture in practically every corner of the Colonial Empire, both as immediate and long-range post-war aims, demand that preparations be put in hand now; and, as we have seen, the Imperial College of Tropical Agriculture is an integral part of the system.

What is remarkable is that it has been possible to keep the establishment actively in being, to continue the recruitment and training of students, to keep the long-term experimental programmes in operation, and to turn out a not inconsiderable body of research. This is a notable achievement; it is something in which we may take a legitimate pride. But it has not been without its rigours, both for staff and students. Most of the academic staff and their families, accustomed to home leave in a temperate climate every two years, have now been continuously in the tropics for six years. Even local travel, which helps to dispel the inescapable tropical *ennui*, has been seriously restricted. There have been periods of food restriction, and even scarcity, more rigorous than at home; and 'digging for victory' in the moist tropics—for that, too, has had to be done—is not quite the same pastime as in our own temperate clime.

Lack of transport provides the clue to the many difficulties. Thus Colonial Office scholars, going out to take the associateship course prior to being posted to different Colonies, have mostly arrived in small batches many months late. For example, the last of those due on October 1, 1942, arrived in the second week of April 1943! As in home universities, the defects of shortened courses have had to be borne. So, too, research work has been hampered by restrictions and delays in the arrival of apparatus and materials.

And so the tale of difficulties mounts up. The near view no doubt suggests a somewhat gloomy picture. But there is clearly another side to it. Agriculture is an art, and art is proverbially long. Nothing is more damaging to agricultural progress than restriction and discontinuity in the scientific research directed towards its improvement. In Trinidad, in spite of all set-backs (and they have been not a few), this essential continuity has been maintained. To those who have held the fort and advanced the tradition of science in its relation to agriculture, under the stress of war, a word of recognition is due.

# OBITUARIES

## Sir Ralph Fowler, O.B.E., F.R.S.

THE death, the tragically early death, of Sir Ralph Fowler in Cambridge on July 28, 1944, at the age of fifty-five, leaves a gap in British and indeed in international mathematical physics which will be hard to bridge in the years that are to come. Whatever Fowler touched, he did well, superlatively well; he was a hard hitter, both at work and games; and he had a quickness of apprehension, and power of plunging into a new subject, of getting abreast of all its details and more than holding his own with it in the presence of its acknowledged experts, at the shortest possible notice, that are exhibited in equal fashion perhaps only in the higher flights of advocacy. He was that rare combination, an accomplished pure mathematician with a sound physical insight. In fact, the only criticism I ever heard of his use of his powers was that he mistook physics as a field for the exercise of mathematical rigour. It was scarcely a fair criticism; only the gruelling training he received in pure mathematics at Cambridge, and the use that he put it to in his early pamphlet on the differential geometry of plane curves, could have given him the experience which was afterwards to mean that no non-rigorous deduction in mathematical physics proper ever escaped his trenchant and sometimes pungently expressed comments. He could make up his mind with lightning rapidity (he was a first-class bridge-player) and his conclusions were always strongly based on common sense, but his mathematical powers ensured that his strokes were savoured with something subtler than mere common sense.

Ralph Howard Fowler was born on January 17, 1889, the eldest son of Howard Fowler, of Burnham, Somerset. He was educated at Winchester (of which he was afterwards a fellow) and at Trinity College, Cambridge, where he was elected to a prize fellowship in 1914 for work in pure mathematics. He already had a commission when he was admitted fellow—I was in chapel at the time, being admitted a scholar, and remember the unaccustomed sight of a gown over an officer's uniform—and while serving as a lieutenant in the Royal Marine Artillery he was seriously wounded in Gallipoli. During convalescence, he encountered A. V. Hill (then a captain in the Cambridgeshires) who was engaged in developing with Horace Darwin what eventually became known as the Darwin-Hill mirror position-finder. The two officers, with the author as assistant, went down to Northolt Aerodrome in March 1916 for the first experiments with this instrument, and there were joined by the late W. Hartree. Thus began A. V. Hill's 'band of brigands' who were to become the A.A. Experimental Section of the Munitions Inventions Department; and thus began R. H. Fowler's interest in mathematical physics. Fowler's main work in the rest of the War of 1914–18 was carried out at Whale Island, under H.M.S. *Excellent*'s hospitality, and besides covering all aspects of the then nascent science of anti-aircraft gunnery, dealt experimentally and mathematically with the fundamental problem of the motion of a yawed shell under aerodynamic forces. These papers, written in conjunction with other well-known mathematicians, and published in the *Philosophical Transactions of the Royal Society*, became classical.

Fowler became a member of the mathematical staff of Trinity in 1919, and turned his attention to the problems of mathematical physics that came to the fore with the return of the late Lord Rutherford to Cambridge as Cavendish professor—problems of kinetic theory, of Aston's mass spectrograph, of collisions 'of the second kind' and the principle of detailed balancing. He also made important contributions to astrophysics. This series of papers developed into a fundamental treatment of problems of statistical mechanics, begun in collaboration with Sir Charles Darwin: evaluations of the enumeration of 'complexions' of a given assembly of similar systems under given external macroscopic conditions, in the forms of coefficients of 'partition functions', were expressed as contour integrals, which in turn were evaluated by the method of 'steepest descents', and led to the identification of a certain mathematical parameter with the absolute temperature, to evaluations of mean energies, mean fluctuations of energy and degrees of dissociation in reversibly reacting constituents. The method was one of extreme generality and power. In essay form it was awarded the Adams Prize of the University of Cambridge in 1925, and in book form it appeared as "Statistical Mechanics", which is now in its second edition and was translated into German. It is a mine of information, of the most detailed kind, on the thermodynamic and quantal properties of dynamical systems in large assemblies—gases (perfect and imperfect), mixed phases, crystals. The first edition contained, too, many astrophysical applications. The work is nowhere easy reading, but its professional competence is amazing. It brought Fowler an international reputation, and led eventually to his joint editorship (with Kapitza) of the Oxford series of Monographs on Physics, and his membership of the editorial board of the newly founded American *Journal of Chemical Physics*.

In the middle nineteen twenties, astronomers had concluded that certain stars, of which the companion of Sirius is the best known, from the evidence of their high-surface temperatures, normal masses and faint absolute luminosities, must have small surface areas and so excessively large densities. It was for some time a mystery as to how matter could exist in this state. In a fundamental paper under the title "Dense Matter", Fowler pointed out that these stars, in their deep interiors, must be examples of ionized gases in the 'degenerate state' to which theoretical physicists had recently been directing attention. This state, differing completely in its physical properties from the classical ideal gas, supervenes under conditions of *relatively* high density and low temperature. The theory was afterwards applied by Sommerfeld to assemblies of electrons in conductors, but to Fowler belongs the credit of first realizing a physical application of the statistical mechanics of degenerate gases.

Fowler was always ready to turn aside to abstract problems of pure mathematics. A notable example was his definitive treatment of the general solutions of the second-order differential equation known as Emden's differential equation, which is of importance in the theory of stellar structure. In 1929 and 1930 there was considerable controversy as to the configurations of a gaseous mass—controversy which is still not settled—and certain empirical results obtained numerically concerning solutions of Emden's equation with non-central boundary conditions attracted Fowler's attention, reminding him of some of his pre-fellowship work. He now found

the clue; and in a set of papers developed a partly geometrical, partly analytical, method of surpassing beauty, which finally classified all solutions of Emden's equation and its generalizations. As G. H. Hardy remarked in a debate on the subject at the Royal Astronomical Society, theories of stellar structure may come and go, but Fowler's contributions to the pure mathematics of the subject have a permanent value.

Fowler had become the mainstay of theoretical physics at the Cavendish, and in 1932 he was appointed to the new Plummer chair at Cambridge. Here he found the fullest opportunity for the exercise of his remarkable versatility and power of assimilating new ideas. Anyone in doubt over an unusual argument, anyone in need of encouraging but salty criticism, always turned to Fowler and came away comforted.

In 1938 Fowler was appointed director of the National Physical Laboratory. But an unexpected illness made it undesirable for him to take up the appointment, and he had the unusual experience of being re-elected to his resigned chair. But he could not be persuaded to reduce his activities. During the present War he undertook important liaison work between British and Canadian science, in Canada, and later he did similar work in the United States. He was created a knight in 1942. Unfortunately, his illness returned, and though he threw himself into further work at the Admiralty, it gradually mastered him. He was attending important conferences up to within a few weeks of his death.

Fowler was elected a fellow of the Royal Society in 1925, and awarded its Royal Medal in 1936. He married Eileen, only daughter of the late Lord Rutherford; she died in 1931. He leaves two sons and two daughters.

Fowler had a forceful, even a masterful personality. As I once put it in a sketch of Fowler for the *Granta*, when Fowler was proctor at Cambridge, he had a short way with any committee he was chairman of, and a short way with the chairman of any committee he was a member of. He could be outspoken to the point of inducing tears, but his subsequent contrition was so endearing that he never left bitterness. He was a man who, starting his scientific career in a promising but by no means excessively distinguished way, went on maturing throughout his life, and attained a fame which surprised even his earliest admirers, but which was wholly deserved, and wholly earned. Had he lived, Fowler would have become one of the greatest scientific powers in the land. He had a tremendous capacity for personal friendships; to collaborate with him on a scientific paper was to embark on high adventure, and the thrill and 'agogness' of working alongside him, when results were being turned out quickly and one was on tip-toes as to what was round the next corner, were things never to be forgotten.

Fowler was big and powerful of frame, and he applied his strength with success to a variety of ball-games. He had claims to distinction as a cricketer, both in batting and bowling; he played an excellent game of both lawn tennis and real tennis; he represented Cambridge at golf and declared (and, we hope, made) many a 'Barnwell no-trumper' on his way home from golf at Mildenhall; he was also a rock-climber.

Fowler was the whole man, of many parts. His life was one of unsparing devotion to high scientific ideals. We cannot over-estimate the loss his untimely death means to Great Britain and to science generally.

E. A. MILNE.

WE regret to announce the following deaths:

Mr. Selskar M. Gunn, vice-president of the Rockefeller Foundation, and formerly director of the Paris office of the International Health Board of the Foundation, aged sixty-one.

Sir Henry Lyons, F.R.S., formerly director of the Science Museum, London, on August 10, aged seventy-nine.

# NEWS and VIEWS

## Prof. T. R. Elliott, C.B.E., F.R.S., and the Beit Trust

MANY generations of Beit Memorial research fellows will hear with regret of the retirement of Prof. Elliott from the honorary secretaryship of the Advisory Board to the Beit Memorial Trustees, an appointment he has held since 1930 when he succeeded the late Sir James Kingston Fowler. The Beit Trust, one of the first great benefactions for medical research in Great Britain, has played a very notable part in the training of a number of skilled investigators who have made important contributions in most branches of scientific medicine. From its inception in 1910, the Trust has been particularly fortunate in its first two honorary secretaries to the Advisory Board, both of whom have been distinguished by their enthusiasm for its work, pride in its achievements and vision in its possibilities. The continuity of the generous policy of the Trust, the ease of its adjustment to changing conditions without any lowering of standards or narrowing of aims, have owed much to their work.

Prof. Elliott, a former Beit fellow (1911–12), became a member of the Advisory Board in 1922, and thus has been able to draw upon his own earlier memories in acting as friend and adviser to many of those he has helped to elect to fellowships. During the last fourteen years his intimate knowledge of the working of the Trust has been of the greatest value to the work of his colleagues on the Advisory Board, and of the Trustees to whom he carried their recommendations. Prof. Elliott will take with him the grateful memories of all who have worked with him on the Advisory Board and of many in all parts of the world who, as Beit Memorial fellows, have had his friendly guidance. He hands on a fine tradition to his successor, Dr. A. N. Drury, director of the Lister Institute.

## Metallurgy at the National Physical Laboratory: Dr. N. P. Allen

DR. NORMAN P. ALLEN, who has been appointed superintendent of the Department of Metallurgy at the National Physical Laboratory in succession to

Dr. C. Sykes, studied metallurgy in the University of Sheffield under Prof. C. H. Desch, graduating B.Met. in 1923 and M.Met. in the following year. He collaborated in research on the die-casting of alloys of low melting point for the Non-Ferrous Metals Research Association, at first in Sheffield and later at University College, Swansea. In 1928 he was appointed to a lectureship in metallurgy in the University of Birmingham, where he obtained the degree of D.Sc. Since 1935 he has been on the staff of the research laboratories of the Mond Nickel Co., Ltd.

Dr. Allen's published investigations, undertaken on behalf of the Non-Ferrous Metals Research Association, have dealt with the effects of gases on non-ferrous metals and alloys, and in a series of papers he has described new methods of examining the solution and release of gases from molten alloys, chiefly of copper, and of the relations between the nature and amount of dissolved gases and the porosity of the resulting ingots and castings. The work involved the design of apparatus for applying both high and low pressures to the alloys when molten, and has been of material help in dealing with problems of porosity in non-ferrous alloys, at the same time providing interesting thermodynamic data.

## Chair of Aviation, Imperial College: Mr. A. A. Hall

THE Department of Aeronautics at the Imperial College of Science and Technology is the largest activity of its kind in the British Empire. The announcement of the appointment of Mr. A. A. Hall as the new head, to succeed Prof. Leonard Bairstow as Zaharoff professor of aviation, is therefore of great interest. Mr. A. A. Hall will be one of the youngest professors in the country. If the course of the War makes it possible for him to take up his new appointment in October 1945 he will then be just over thirty years of age. He comes from Liverpool. Educated at the Alsop High School, Liverpool, and at Clare College, Cambridge, he obtained first-class honours in the Mechanical Sciences Tripos of 1934, with distinction in aeronautics, in thermodynamics, in applied mechanics and in the theory of structures. He was awarded the Rex Moir prize in engineering, the John Bernard Seely prize in aeronautics, the Ricardo prize in thermodynamics, and the Robins prize of Clare College. After a short period at the Royal Aircraft Establishment, he returned to Cambridge with an Armourers and Braziers' research fellowship to pursue aerodynamic research under Sir Melvill Jones and Sir Geoffrey Taylor. The work he did then, on the turbulence in a free stream and on the laminar and turbulent boundary layer, was an outstanding contribution to the subject. He joined the staff of the Royal Aircraft Establishment in 1938 and his activities there have covered a wide field—aerodynamics, wind tunnel design, and jet propulsion, followed since the outbreak of war by investigations on night interception of aircraft and on many scientific and engineering problems in the field of aircraft armament. In all he has shown high qualities of original thought and of leadership—the best augury for his future in a most responsible position.

## Miss Grace Wigglesworth

MISS GRACE WIGGLESWORTH retires in September from the Manchester Museum, where she has served in the Botanical Section as assistant keeper since 1910. An old pupil of the Manchester High School, she entered Owens College in 1900 and graduated B.Sc. with honours in botany in 1903. In the same year "The Victoria University of Manchester" received its title, and Miss Wigglesworth continued her botanical studies in the University as an honorary research fellow until 1907. During this period she published several papers, the first in 1902 in vol. 1 of the *New Phytologist*, entitled "Notes on the Rhizome of *Matonia pectinata*, R.Br.". This was followed by "A Note on the Cotyledons of *Ginkgo biloba* and *Cycas revoluta*" (*Ann. Bot.*; 1903), "The Papillae of the Epidermoidal Layer of the Calamitean Root" (*Ann. Bot.*; 1904) and "The Young Sporophyte of *Lycopodium complanatum* and *L. clavatum*" (*Ann. Bot.*; 1907).

In 1907 Miss Wigglesworth was appointed lecturer in botany at the L.C.C. Clapham Day Training College, but in 1910 she returned to Manchester as assistant keeper in the Museum. She was able to devote some time to research, and further published papers are "The Development of Cœnobia from Resting Spores in the African Water Net (*Hydrodictyon*)", 1928; "A New Californian Species of *Sphaerocarpus*", 1929; and "South African species of *Riella*", 1937. But much important work remains unpublished. She spent several years working on the developmental morphology of *Polytrichum commune*, and has more recently been working on Prof. W. H. Lang's collection of Malayan Hepaticæ. She is a member of the Bryological Society and has an expert knowledge of hepatics. During her period of office in the Museum Miss Wigglesworth has been responsible for the reception, housing and care of the valuable herbaria of Leo Grindon and Cosmo Melvill. Her intimate knowledge of the contents of the Museum has been invaluable to members of the staff of the Botanical Department of the University who have been able to make use of its resources for teaching purposes. Her personal charm and kindliness have endeared her to all who have known her, and her many friends wish her a happy retirement, after a most fruitful scientific career.

## Manchester Joint Research Council

THE vice-chancellor of the University of Manchester and the president of the Manchester Chamber of Commerce have announced the personnel of the Manchester Joint Research Council which is being set up jointly by the Chamber and the University. Representing the University are: Prof. P. M. S. Blackett, Dr. C. T. J. Cronshaw, Prof. D. R. Hartree, Prof. J. R. Hicks, Prof. Willis Jackson, Prof. J. Jewkes, Sir William Clare Lees, Dr. J. E. Myers, Prof. W. E. Morton, Prof. M. Polanyi, Sir Ernest Simon, Sir John Stopford (vice-chancellor), Sir Raymond Streat and Prof. F. C. Thompson. The Manchester Chamber of Commerce will be represented by Mr. J. Harold Brown, Mr. E. A. Carpenter, Mr. J. Curwen, Mr. R. H. Dobson, Mr. John S. Dodd, Dr. A. P. M. Fleming, Mr. H. M. Harwood, Mr. A. H. S. Hinchliffe (president), Mr. Frank Longworth, Mr. L. E. Mather, Mr. N. G. McCulloch, Earl Peel, Mr. C. G. Renold, Mr. A. V. Sugden and Mr. John F. West. The first meeting of the Council will be held at the University on October 9.

## School Certificate Mathematics

A conference of representatives of examining bodies and teachers' associations was held in April 1944 and drew up a new syllabus designed to sweep

away the traditional divisions of the various mathematical subjects studied at the School Certificate stage. The suggested new syllabus, which has now been printed with specimen papers (Mathematical Association), is arranged under seven headings: numbers; mensuration; formulæ and equations; graphs, variation and functionality; two-dimensional figures; three-dimensional figures; practical applications. The main points of it may be summarized as follows. (1) The whole syllabus is designed to bring mathematics more closely into relation with the life and experience of the pupils. (2) It is intended to be alternative to the existing syllabuses and of equal weight. It is not suggested that it has been framed for weaker candidates by any lowering of the standard. (3) The fusion of the relevant mathematical subjects, particularly geometry and trigonometry, should be developed by the setting of mixed papers, three in number each of $2\frac{1}{2}$ hours duration, so that complete freedom of method should be permitted. This freedom should extend to the use of mathematical tables and instruments. (4) To remove much of the emphasis from formal work, only proofs of key theorems should be demanded. From these key theorems many others can be deduced and proofs of these are unnecessary. The Conference admits that the list of key theorems given is not ideal; but it is about the desired length of the essential formal work. (5) Perhaps the most striking feature of the syllabus is the inclusion of the beginning of the calculus, which should grow naturally and easily out of the consideration of graphs. (6) Heavy arithmetical calculations and algebraic manipulation must be excluded. The omission of these will allow the due emphasis needed on the all-important ideas connected with functionality, which begins with graphs and leads naturally to gradients. The whole report is inspiring, and if the basic ideas of it can be successfully carried out, mathematics should indeed become a really vital subject. Too long have we encouraged the blind manipulation of the symbol, with little or no relation to reality, while the deadening influence of the traditional formality in geometry has almost completely obscured the many ramifications of the subject in everyday life. It is to be hoped that this encouraging beginning will lead to the removal of many more artificial divisions in the mathematical honeycomb.

## Ley Farming

"ALTERNATE HUSBANDRY", issued as Joint Publication No. 6 by four of the Imperial Agricultural Bureaux (Aberystwyth. 5*s*.), has been compiled by a number of authors, each of whom deals with different aspects of the subject. It is emphasized that the use of leys in rotation under a wide range of climatic and soil conditions and in combination with a great variety of crops is a question upon which much research is needed, and that the purpose of the publication is largely to provide a basis for that research. The system is flexible, but cannot be applied to all types of agriculture, it being unsuitable, for example, in semi-arid or wet tropical regions where problems of establishment and management multiply considerably. The publication opens with a geographical review in which the trends of development in the practice in fifteen different countries and regions are described. Later chapters deal with the question in detail, showing among other matters that the type of ley selected depends largely on the climatic factor, and that a closer study of the root systems of herbage plants is required before the effect of the various species and their different combinations on the soil can be properly assessed. It is generally recognized that a ley is a method for improving the structure of the soil, as it increases granulation, which both benefits the crop and helps to prevent erosion. Other problems such as weed control, soil conservation, plant health and the economic factors involved in the system are also discussed. As regards the animal crop many factors are involved; but it seems likely that the regular ploughing of grassland will reduce the liability to disease even in spite of increased concentration of stock. For those requiring more detailed information, a list of more than three hundred references are arranged in groups appropriate to each chapter.

## Birth-rate in the United States

ACCORDING to an annotation in the February issue of the *Statistical Bulletin* (the organ of the Metropolitan Life Insurance Company of New York) the War has caused not only a sudden rise in the birth-rate but also very marked though undoubtedly temporary changes in the seasonal pattern of the birth-record. In contrast with the normal pattern of a major peak in the summer months, a minor peak in February and March, and low points about May and December, in 1942 there was a rise in the birth-rate through most of the year with a high peak in December; the accelerated rise in the last quarter of 1942 represented the increased number of conceptions in the period immediately following the attack on Pearl Harbour on December 7, 1941. In 1943 the births were at a maximum in January with a general trend downwards throughout the rest of the year. There was a seasonal dip in May, but births in that month were higher than in November and December. Births in July and August were lower than in each of the first three months of the year and lower than in June. The experience of the last few months clearly shows that a continuing decline of the birth-rate may be expected for the duration of the War, and for at least a year after the cessation of hostilities.

## Irrigation Research in India

THE report for the year 1941 of the Punjab Irrigation Research Institute describes fully the researches on soil grading and soil density, water seepage, movement of silt beds, model investigation of water flow of rivers, weirs and headworks, and land reclamation with particular reference to salt accumulation. In addition to these main researches, many original methods of analysis and measurement are described, and a section deals with the sampling of suspended silt. The volume, which consists of 230 pages and 210 figures or photographs, would be more useful for reference purposes if an index had been provided.

## The Royal Institute of Chemistry

THE Council of the Royal Institute of Chemistry recently decided that the offices of registrar and secretary of the Institute, previously held by Mr. Richard B. Pilcher, should be separated. To the office of registrar, the Council has appointed Mr. R. Leslie Collett, who has for nearly twenty years been assistant secretary, and to the office of secretary, Dr. H. J. T. Ellingham, of the Imperial College of Science and Technology. Both appointments will take effect from January 1, 1945.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Synthesis of Amylopectin

NATURAL starch is a mixture of two components, which can be separated in a number of ways although it is doubtful if complete separation has yet been attained. The names, amylose and amylopectin, used earlier in a different sense, may be conveniently retained to describe the two components. Amylose, forming about 25 per cent of whole starch, is constituted of unbranched chains of glucose residues, the members being mutually linked by $\alpha$-1 : 4-glycosidic linkages. Amylopectin possesses for the most part the same 1 : 4 glucose linkages and forms about 75 per cent of natural starch, but its chain structure is branched or laminated through the lateral linking of its shorter lengths of 1 : 4 glucose chains by certain $\alpha$-1 : 6-glycosidic bonds.

C. S. Hanes[1] isolated from the potato (and from the pea) a phosphorylase which effected, in the presence of phosphate ion, the conversion of whole starch into glucose-1-phosphate, and demonstrated that this reaction was, in a sense, reversible *in vitro*. The polysaccharide produced in this reverse reaction was not, however, identical with whole starch but with only one of its components. At least 85 per cent of the Hanes' synthetic starch had the properties of an amylose. Thus, (1) it retrograded rapidly from solution, (2) it gave a pure blue colour with iodine, and (3) it was completely hydrolysed to maltose by $\beta$-amylase. End-group assay showed its continuous chain-length to be 80–90 glucose members[2] whereas that of whole starch averages 24–30 units. Furthermore, the molecular weight of the methylated product determined osmotically corresponded to a particle size of 80–100 glucose units, thus providing clear evidence of the absence of branching in this synthetic amylose.

We now have to report the separation from the potato of an enzyme system which catalyses the conversion of glucose-1-phosphate into a polysaccharide which is not amylose but which is probably identical with the amylopectin component of natural starch. This new polysaccharide is constituted entirely of *d*-glucose units, it gives a purple-red colour with iodine, it is soluble in water and does not retrograde from solution. In these properties it is not to be distinguished from the amylopectin fraction of natural starch. Furthermore, it is attacked by $\beta$-amylase and maltose is liberated, but, as with natural amylopectin, the hydrolysis is arrested before the conversion into maltose is complete. This behaviour is characteristic of the branched-chain type and distinguishes it sharply from the unbranched, amylose type which is entirely converted to maltose by $\beta$-amylase. Under identical conditions and by the same preparation of $\beta$-amylase, synthetic amylopectin and natural amylopectin were converted to maltose to the extent of 45 and 49 per cent respectively. These figures represent resting points in the hydrolysis and were attained after about four hours in each case.

In an exploratory experiment, a few grams of the synthetic amylopectin have been methylated and the proportion of end-group assayed. The result quite definitely indicates that the substance is not amylose, inasmuch as the number of glucose residues in the unit chain is 20. We lay no stress on the actual numerical value given for the chain-length because this preliminary assay was carried out on too small a quantity of methylated product to conform to the usual standard of accuracy, and, moreover, the sample submitted to assay contained only 41 per cent methoxyl as compared with the usual 44–45 per cent. The margin of error is not, however, greater than $\pm$ 10 per cent. Although much dubiety is attached to the estimation of molecular weight by viscosity measurement, it may nevertheless be of significance that our viscosity measurements indicate a molecular size corresponding to about 100 hexose units when the $K_m$ constant for methylated whole starch is used. With this reservation in mind, the particle size is seen to be some five times the size of the unit chain, a fact which supports the evidence of branching given by the observation of the cessation of $\beta$-amylase activity at 45 per cent conversion.

Hassid and McCready[3] find for separated natural amylopectin, by end-group assay, a unit chain-length of 25 glucose residues and a molecular weight (by viscosity measurement) corresponding to 450 glucose units. The same experimental error margin ($\pm$ 10 per cent) will apply to this assay figure as to ours for the reason that less than 0·5 gm. of end-group was estimated.

It is our intention to repeat the end-group assay and also to determine the molecular weight by the more trustworthy osmotic method when adequate quantities of synthetic amylopectin become available.

It is too early to discuss the bearing of these observations on the question of starch synthesis in the plant; but we have some reason to believe that Hanes' amylose-synthesizing enzyme participates also in the enzyme system responsible for the synthesis of our amylopectin. It would appear that an additional factor—the *Q* factor—is present in our enzyme preparation which modifies the normal synthetic activity of the phosphorylase (*P* enzyme) and enables 1 : 6-glycosidic cross-linkages to be formed.

It is perhaps important to mention that our synthetic amylopectin cannot be an amylolytic degradation product of an amylose synthesized in the normal way by phosphorylase. We have taken the greatest care to ensure the absence of both $\alpha$- and $\beta$-amylase from our enzyme preparations.

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[1] Hanes, C. S., *Proc. Roy. Soc.*, B, **128**, 421; **129**, 174 (1940).
[2] Haworth, W. N., Heath, R. L., and Peat, S., *J. Chem. Soc.*, 55 (1942).
[3] Hassid, W. Z., and McCready, R. M., *J. Amer. Chem. Soc.*, **65**, 1159 (1943).

## Penicillinase from *B. subtilis*

IN the bacteriological examination of blood or exudates of patients under treatment with penicillin, it is necessary to inactivate any penicillin present if viable penicillin-sensitive organisms are to grow. The routine testing of penicillin products for sterility also requires a means of neutralizing the antibacterial effect of penicillin. The coli-penicillinase method[1] has the disadvantages that the preparation is turbid and the activity of the final product varies.

Among many chemical and biological materials tested for penicillin-inactivating properties, we have found a strain of *B. subtilis*, previously isolated as a chance contaminant, that was a good source of penicillinase. Our original method was as follows:

24-hour agar cultures in 20-oz. bottles were washed off in a minimum amount of saline. The suspension was then standardized to give an opacity equal to 10 times that of tube 2 of the Brown's opacity tube set. 60 ml. of the suspension were centrifuged for 30 minutes at 5,000 revolutions per minute (radius, 13 cm.). The clear supernatant fluid was decanted and the residual organisms were transferred to an agate mortar and ground for 30 min., when a stained smear showed very few undisrupted bacteria present; 25 ml. of distilled water were added and extraction proceeded at room temperature overnight. After centrifuging until the supernatant fluid was clear (about 10 min.), the deposit was removed and the supernatant fluid was sterilized by Seitz filtration.

Another and a simpler method is to grow the organism in a 100 ml. bottle of papain digest broth at 37° C. for two to three days. The metabolic fluid is then sterilized by Seitz filtration. In preliminary tests 0·5 ml. of the filtrate inactivated 250 Oxford units of sodium penicillin after one hour's contact at room temperature. Control tests showed that the metabolic fluid had no adverse effect on the strain of *Staphylococcus aureus* used as test organism.

showed slight inhibition (in a dilution of 1 : 4) of the test organism.

There is some evidence to show that free formation of penicillinase in the metabolic fluid is marked in penicillin-resistant strains of *B. subtilis*, and that the amount of the penicillinase is related to the strength of the surface pellicle on the culture. Investigations are now being made into the properties of penicillinase produced in agar cultures. The data at present available show that 1 ml. of a dilution of 1 : 250 of the culture fluid still inactivates 50 O.U. of penicillin after four hours incubation. In routine sterility tests the fluid is added to the dried or dissolved samples (for example, to 1 ml. containing 3,000–4,000 O.U.) and left in contact for 24–48 hours at 37° C., after which the penicillin is inactivated. The metabolic fluid kept in the refrigerator over a period of 3–4 weeks shows no deterioration in potency; heating to 80° C. for 30 minutes destroys part of the penicillinase activity.

Penicillinase may safely be added to exudates and body fluids from patients receiving penicillin treatment, for it does not inhibit the growth of bacteria cultivated from such specimens.

The inhibitory effect of penicillinase on penicillin can be clearly shown either in broth tubes using the serial dilution method, or by inseminating agar plates containing penicillin-sensitive organisms; in fact, Heatley's cup method or filter paper disks can be used for estimating penicillinase potency. Alternatively, this can be done by putting the material to be tested on to 'Cellophane' sheets "P.T. 300" on the surface of the agar plates. The penicillinase does not diffuse into the agar and does not pass through the 'Cellophane' membranes as does penicillin, and this permits the test to be easily performed.

| | 24 hours | | | | | 48 hours | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Turbidity | Deposit | Pellicle | *p*H | Activity | Turbidity | Deposit | Pellicle | *p*H | Activity |
| Hartley's broth | + | 0 | +++ | 7·2 | + | + | ± | +++ | 7·0 | ++ |
| Peptone water ('Difco Bacto') in 8 per cent $CO_2$ | + | 0 | +++ | 7·8 | ++ | ± | 0 | +++ | 7·2 | ++ |
| Peptone water (French) | ± | 0 | +++ | 7·4 | + | ± | 0 | +++ | 7·3 | ++ |
| Peptone water (Paines and Byrne) | + | 0 | ++ | 7·4 | + | + | 0 | ++ | 7·2 | ++ |
| Peptone water (Evans) | ++ | 0 | +++ | 7·0 | + | ++ | ± | +++ | 6·8 | ++ |
| Peptone water ('Difco Proteose') | ± | 0 | +++ | 7·4 | + | ± | ± | +++ | 7·0 | ++ |
| Peptone water ('Difco Bacto') | ++ | 0 | +++ | 7·8 | ++ | ± | 0 | +++ | 7·0 | ++ |
| Papain digest broth | + | 0 | +++ | 8·0 | + | ± | ± | +++ | 7·6 | ++ |

+ = 50 O.U./ml. inactivated in 6 hours. ++ = 50 O.U./ml. inactivated in 2 hours

We examined the influence on penicillinase production of different conditions of growth—such as presence of oxygen, carbon dioxide, sugars and serum. Glucose (1 per cent) in papain digest broth decreased penicillinase production, as did 5–10 per cent human serum in the medium. Anaerobic cultivation or growth in 8 per cent carbon dioxide had no direct influence, provided growth of the cultures took place. Penicillinase was produced when the strain was grown in 2 per cent peptone water, but in this medium the addition of glucose did not decrease the amount formed.

The accompanying table summarizes the characteristics of the penicillinase obtained on different media.

The lower *p*H of the glucose broth had no direct effect on the rate of penicillinase production, for in many of our tests with other media we found as much penicillinase to be produced at *p*H 5–6 as at *p*H 7·5. The addition of other carbohydrates (1 per cent starch, mannitol, maltose, lactose) to the medium had a less marked effect in depressing the formation of penicillinase. Although the amount of penicillinase formed with different peptones is similar, it is preferable to use the purer brands, because the metabolic fluid from cruder peptones, containing impurities, showed slight inhibition (in a dilution of 1 : 4) of the test organism.

This work was carried out in connexion with investigations of the Therapeutic Research Corporation of Great Britain.

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[1] Harper, G. J., *Lancet*, ii, 569 (1943).

## Dextran and Levan Molecules Studied with the Electron Microscope

THE fundamentally improved designs for the electron microscope made in recent years by different workers have led to such an improvement in the resolving power that a direct study of giant molecules with the aid of this instrument may contribute in

a certain degree to our knowledge of their appearance. If we except the researches on viruses, the following investigations already performed in this direction should be mentioned: M. von Ardenne[1] and W. M. Stanley and Th. F. Anderson[2] have succeeded in photographing hæmocyanin and edestin; E. Husemann and H. Ruska have also photographed glycogen[3] and iodobenzoylglycogen[4]. All these molecules, however, are more or less spherical ($\phi \sim 100$–300 A.). They therefore appear on the plates as small diffuse dots. The electron-microscopical investigation of these molecules is facilitated by their more compact structure, which gives a good contrast with the substrate. In the case of iodobenzoylglycogen, this contrast has been further improved by the introduction of heavy atoms into the molecule.

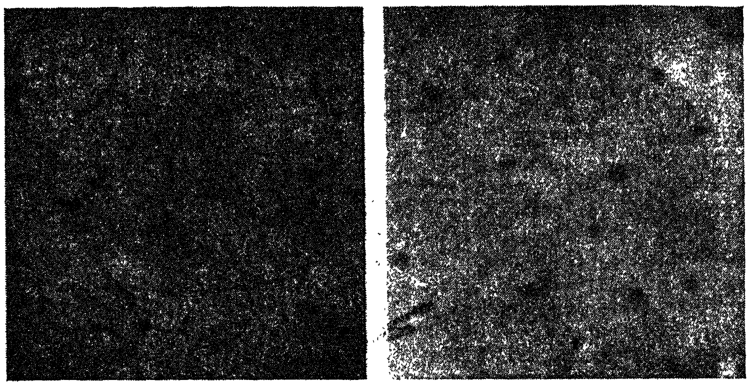

FIG. 1. ELECTRON-MICROSCOPE PHOTOGRAPHS OF (a) DEXTRAN MOLECULES, × 30,000; (b) LEVAN MOLECULES, × 35,000.

In the course of an investigation of the high-molecular components of sugar beet juice, one of us has encountered a polysaccharide of very high molecular weight, dextran[5]. This substance is obtained by the action of a bacterium, *Leuconostoc mesenteroides*, on the juices of the sugar beet, and its composition corresponds to the empirical formula $(C_6H_{10}O_5)_n$. The researches of Levi, Hawkins and Hibbert indicate that the dextran molecule consists of a long principal chain to which side-chains are attached[6]. (Physico-chemical measurements also indicate that the dextran molecule is thread-like[5].) The side-chains may consist each of five glucose units[6]. Since the length of a glucose unit is 5 A., the presence of these side-chains would give the whole molecule a breadth and thickness of 50 A. Consequently it may well be visible under the electron microscope, designed by Prof. Manne Siegbahn, at the Research Institute for Physics in Stockholm, which has a resolving power of about 30 A.

The customary technique has been employed in the electron-microscopical investigation; namely, a dilute solution of the water-soluble dextran (0·002 per cent) was allowed to dry on the foil ($\sim 0{\cdot}008\,\mu$) on the object-holder. The direct electron-optical magnification has been maintained at 7,000 ×, in addition to which the fine-grained plate allows a subsequent enlargement of up to 10 ×. Fig. 1*a* shows the result of such an exposure with total magnification 30,000 ×. On further dilution, pictures are obtained where the dextran threads lie farther apart. The long and branched form of the molecules gives them a strong tendency to cohere, so that in the photograph certain threads may correspond to several molecules lying side by side. In several places, however, extremely thin threads may be distinguished, the thicknesses of which are rather uniform, namely, 30–100 A.; this corresponds well with the estimated molecular thickness of $\sim 50$ A. This estimation of the thickness is naturally quite uncertain in view of the fact that the resolving power of the microscope is just of this magnitude. It is an interesting feature that it is possible, on many different photographs, to distinguish small nodes situated on the fine molecular threads at equal distances from each other, namely, $\sim 800$ A. This phenomenon, unfortunately, is not so evident in the reproductions. The distance between two nodes thus corresponds to about 160 glucose units[7].

We have also taken photographs of levan molecules, that is, polysaccharide molecules built up exclusively of fructose. The levan used by us was prepared from a solution of crude sugar, seeded with a culture of *Bacillus vulgatus*. Investigations performed by one of us with the help of Svedberg's ultracentrifuge showed that this levan has an extremely high molecular weight. Sedimentation constants of the order of 200–300 × $10^{-13}$ and diffusion constants of the order of 0·2 × $10^{-7}$ were measured. If these values are substituted in Svedberg's molecular weight formula, particle weights of the order of 50–100 million are obtained, which values are considerably higher than those usually encountered among soluble polysaccharides. It may well be asked whether these particles with weights of one hundred million may be called molecules. Everything indicates, however, that the particles, despite their size, are stable. The sedimentation constant, for example, is unaltered after the levan has been precipitated with alcohol, dried and redissolved. These experiments with the ultracentrifuge, etc., will be published at a later date by B. Ingelman.

To judge from Fig. 1*b* (total magnification 35,000 ×) these levan molecules would appear to have a more compact structure than the thread-shaped dextran molecules. The particle size varies in a striking manner, which is also to be seen in the ultracentrifugal data. The electron-microscopical photographs indicate, as do the experiments with the ultracentrifuge, an extremely high molecular weight.

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[1] von Ardenne, M., "Elektronen-Übermikroskopie" (Berlin, 1940).
[2] Stanley, W. M., and Anderson, Th. F., *J. Biol. Chem.*, **146**, 25 (1942).
[3] Husemann, E., and Ruska, H., *J. prakt. Chem.*, **156**, 1 (1940).
[4] Husemann, E., and Ruska, H., *Naturwiss.*, **28**, 534 (1940).
[5] Grönwall, A., and Ingelman, B., *Acta Physiol. Scand.*, in the Press.
[6] Levi, J., Hawkins, L., and Hibbert, H., *J. Amer. Chem. Soc.*, **64**, 1959 (1942).
[7] Ingelman, B., and Siegbahn, Kai, *Ark. Kem., Min. Geol.*, **18B**, No. 1 (1944).

## A Simple Fluorometer of the Duboscq Type

VARIOUS fluorometric methods are employed in determining riboflavin and thiamin. The fluorescent substance is freed, and in the final stage is compared with solutions of known concentration. Weisberg and Levin[1] recommended the use of a block-comparator, but later authors[2,3,4] employ a photo-cell connected with a galvanometer for testing the intensity of fluorescence. These photocell arrangements, however, are very expensive.

The method described below is simple and relatively inexpensive. The light-source, a U-shaped Hanovian quartz burner, is projected on to the cups of a Duboscq colorimeter by means of a flask so that each branch of the U-shaped burner illuminates one cup. The fields of the colorimeter are then matched in the usual way and the intensities compared. The advantages of this method are as follows. (1) Both cups are illuminated by the same light-source; therefore changes in the output of light cannot influence the readings. (2) In passing through the liquid the exciting light is partially absorbed; for this reason sample-holders are kept as short as possible in fluorometric work. On the other hand, only low concentrations of fluorescent matter yield a linear response. (3) When illuminating the cups through the window at the bottom, the whole length of the cup cannot be evenly illuminated. In my arrangement, however, the exciting light enters from the front. Hence (*a*) the activating light passes through only the width of the cup (the path thus being rather short); (*b*) the whole length of the cup is evenly illuminated; (*c*) since the cups are viewed through the colorimeter from above, the bright halves of the fields can be easily matched.

The light-source is a 220-volt Hanovian U-shaped burner. The light passes through a Wood's filter to a 500 ml. round-bottom flask filled with distilled water or a saturated solution of copper sulphate (to exclude the red portion of the spectrum transmitted by Wood's filter). If the colorimeter is not fitted with blackened rods, both rods are covered with black varnish and only the bases are left free. The supports of the cups of the colorimeter are copied from the original supports. A ring is soldered on to the support. Then two test-tubes with flat bottoms are fitted into the ring and sealed to it. The size of these tubes depends on the length and diameter of the rods, in our case 60 mm. and 14 mm. respectively. To avoid reflexions, a black ring of about 10 mm. height is painted on the outside of the cups. To protect the eyes an ultra-violet absorbing filter (or an ordinary photographic plate, fixed and bathed in picric acid) is inserted into the eyepiece or between rods and eyepiece.

The estimation of fluorescein is given as an example. (1) Solutions of sodium fluorescein, 0·2, 0·4, 0·6, 0·8, 1·0 and 1·2 gamma/ml., are prepared. (2) Both cups are filled with 0·2 gamma/ml. sodium fluorescein; and the rods are brought to the same position, say, 50 mm. (3) Now a piece of white paper is put up immediately in front of the cups. Then lamp, colorimeter and flask are so adjusted as to project on each cup one branch of the 'U'-lamp. To get an illumination of the whole width of the test tubes, these should be slightly out of focus. Then the paper is removed and the whole arrangement shielded against daylight by a black cloth. By small movements of the stand (but not by moving the rods) a position can be found where both halves of the field are evenly illuminated. Without moving the stand, both rods are now brought to, say, 30 mm.; then again both halves of the field should be equal. Between 0·2 and 1·0 gamma/ml. the relation between scale readings and concentration is a linear one. (4) When determining the concentration of an unknown solution of fluorescein, the unknown is diluted so as to give a fluorescence slightly stronger to the naked eye than the 0·2 gamma/ml. solution. One cup is filled with 0·2 gamma/ml. fluorescein, the other one with the diluted unknown. The rod dipping in the 0·2 gamma/ml. solution is brought to, say, 50 mm. By moving the rod, both fields are matched and the concentration of the unknown read off from a reference diagram.

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[1] Weisberg, S. M., and Levin, J., *Ind. and Eng. Chem.*, Anal. Ed., 9 (1937).

[2] Schumacher, A. E., and Heuser, G. F., *Ind. and Eng. Chem.*, Anal. Ed., 12 (1940).

[3] Conner, R. T., and Straub, G. J., *Ind. and Eng. Chem.*, Anal. Ed., 13 (1941).

[4] Najjar, V. A., *J. Biol. Chem.*, 141 (1941).

## Natural Selection in the Six-spot Burnet Moth

THE larva of the common six-spot burnet moth (*Zygaena filipendulæ* L.) forms an elongated cocoon on grass or other stems often at a height of six or more inches above the ground. Sometimes, however, the cocoon is spun on low vegetation or a twig in a hedge.

During last summer, when collecting large numbers of cocoons to breed the parasites, I noted that cocoons affixed to a coarse-meshed wire netting fence bordering a road had often been opened and the contents extracted. This was also the case with cocoons on a hawthorn hedge, but was not so with cocoons on tall upstanding grass stems in the open. The tentative conclusion that the enemy was a bird was confirmed when I saw a great-tit perch on the wire fence, open the end of a cocoon, pull out the larva inside, and thrust it into the mouth of a clamorous young one close by. The damage to this cocoon was similar to that previously noted. Thus it seems that a cocoon is liable to attack by a bird *which can reach it.*

This summer I have taken notes on the fate of all the cocoons on the wire fence for a length of about eighty yards. Each one, as soon as the imago emerged, or after it had been opened, was pulled off the fence and recorded. The results, during May 24–July 10, were as follows: opened and larva or pupa extracted, 22; opened, larva or pupa pecked and damaged but not extracted, 2; moth emerged, 8; moth formed but failed to emerge and died, 2; larva or pupa destroyed by Hymenopterous parasites, 3. Thus out of 37 on the fence, no less than 24 were destroyed by birds—a percentage of 64·8. I had hoped that it would be possible this year also to record the fate of cocoons out of reach of birds, but pressure of work has prevented this, and I have only the unrecorded experiences of last year.

Here is a promising and convenient subject for investigation by school scientific societies, for the

full-fed larvæ are easily found in quantity early in the summer term. A test could also be made of the presence of an instinct in the larva to make its cocoon on a tall waving grass stem rather than on more solid objects, and also whether the larva will be satisfied with any height of stem, or will come down again from one that is too short for safety and seek for a longer one. It is obvious that such an instinct would be selected by attacks such as have been described.

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## Stability after the War

THE programme of the United Nations, as broadcast at the end of 1943, may at its briefest be stated thus: the Germans and Japanese are to be defeated and disarmed, and thereafter watched for so long a time as may be necessary by an armed force controlled by the United Nations, who are firmly resolved to remain united.

Historical facts, taken alone, do not predict the future; they do so only if they are combined with some hypothesis. A general form of hypothesis for the quantitative interaction of two entities is a pair of simultaneous differential equations, having time $t$ as independent variable. Almost the simplest of such pairs is

$$dx/dt = g - \alpha x + ky, \qquad dy/dt = h + lx - \beta y, \qquad (1)$$

where $g, h, \alpha, \beta, k, l$, are constants. The most relevant of the quantitative historical facts are the numbers of persons engaged on war-preparations in the opposing groups. Let these be $x$ and $y$. It is then found that the equations (1) are capable of describing the European $x$ and $y$ for the years 1908–13 and again for 1933–38, during the greater part of the arms-races[1]. Moreover, the constants have psychologically intelligible names, thus: $g$, $h$, grievances and ambitions; $k$, $l$, defence coefficients; $\alpha$, $\beta$, fatigue-and-expense coefficients. This analysis emphasizes, what is also obvious to common sense, namely, that if the several nations, now united, were to attempt to regain their former so-called freedom, sovereignty and independence, then after the present War had faded out of mind, disastrous arms-races would be likely to develop between them.

The other essential part of their programme is the submission of the defeated. Equations (1) are too simple to describe defeat or submission. For this purpose it is necessary to introduce at least the quadratic term in the constant $\rho$, which has been called a 'submissiveness', thus[2]

$$\left.\begin{aligned} dx/dt &= g - \alpha x + ky, \\ dy/dt &= h + lx\{1 - \rho(x-y)\} - \beta y. \end{aligned}\right\} \qquad (2)$$

It is very ominous that the turn in the year 1930 from the long pause into the arms-race can be described by equations (2). I am not saying that no other motives were operative. On the contrary, it seems almost certain that the great trade depression and the fading of war-weariness were involved. But I do say that there is no warrant either in those facts or in that theory for the belief that Europe will be permanently stabilized by submissiveness in the presence of grievances, ambitions, defensiveness, and the dislike of fatigue and expense. Balance of power, according to the theory, may be of various types, some stable, some unstable. The need for some other and more binding motive is clearly indicated.

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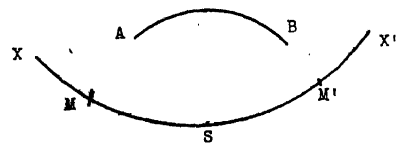
Argyll. July 1.

[1] *Nature*, **135**, 830; **136**, 1025; **142**, 792; and much yet unpublished.
[2] "Generalized Foreign Politics", 23 (Camb. Univ. Press, 1939).

## A Halo Phenomenon

AT 10.15 a.m. G.M.T. on May 2 last some cirrus clouds drifted across the sun; I suspect that they were the remains of condensation trails. As they passed over, I noticed a very peculiar halo phenomenon. The part first visible was the arc $M'X'$; I did not suspect that it was part of a halo circle, though it struck me that it was very like one; I took it to be a long wisp of cirrus or part of a condensation trail. But there then appeared at $M'$ a very brightly coloured parhelion, and at the same time I noticed part of a 22° halo at $A,B$. A few minutes later the arc $X'M'$ had extended through the sun ($S$) to $M$ and $X$; there was another brightly coloured parhelion at $M$; I think that $M$ and $M'$ were rather more than 22° from the sun. The whole phenomenon lasted a very few minutes; I went indoors to get a camera, but by the time I came out again it was all over.




I am quite sure that the arc of the circle through the sun was part of a vertical circle and not part of the horizontal parhelic circle, though like the latter it was white. I am not sufficiently up in meteorological optics to know whether a white vertical circle passing through the sun at its lowest point has been previously observed, but in any event it must be extremely rare. The figure is purely diagamatic; there was no time to take any measurements.

C. J. P. CAVE.
Stoner Hill, Petersfield.

## Centenary of Dalton's Death

THE Manchester Literary and Philosophical Society, which was so closely associated with John Dalton during the whole of his life in Manchester, is commemorating his work on the occasion of the centenary of his death which falls this year. The first meeting of next session is to be devoted to a memorial lecture. In connexion with it the Society hopes to publish a memorial volume in which it would be of interest to give the whereabouts of relics of Dalton, many of those which the Society possessed having been destroyed as a result of fires started by enemy action. The secretaries would therefore welcome any information relating to Dalton's scientific interests or his connexion with the Society. They are also in a position to receive gifts or offers of gifts.

C. M. LEGGE.
D. E. WHEELER.
(Hon. Secretaries.)
12 Brooklands Avenue,
Withington,
Manchester, 20.

# RESEARCH ITEMS

## Mechanism of Visceral Pain

EXPERIMENTAL morphologists will be interested in the two Lettsomian Lectures on the mechanism of visceral pain delivered by Henry Cohen of Liverpool before the Medical Society of London (see *The Lancet*, 764; June 10, 1944). In the first lecture, Prof. Cohen surveyed and criticized the clinical and experimental data available at present; in the second he discussed the hypotheses which have been formulated to explain why viscera which are normally insensitive to painful stimuli will often reveal themselves by pain in states of disease. None of these hypotheses satisfies Prof. Cohen. It seems necessary, he believes, to postulate a constant stream of subthreshold impulses from the end organs of all pain fibres to the central nervous system, which do not enter central subconsciousness unless central inhibition is lowered. Even an increase in these may not pass the threshold unless it is reinforced by impulses from somatic structures within the same somatic innervation, and vice versa. The metamere, being the phylogenetic unit, renders it unlikely that impulses from any structure within it will reach closely related areas in the sensorium. When any pain impulses, or the sum of them all, rises above the threshold, pain is localized in the segment. If the somatic component of these impulses is cut off, a much stronger stimulus is required in the viscus if pain is to be experienced, and it may then be felt, not only in the segment, but also in the anæsthetized part.

## Life-History of a Mite

STUDENTS of the Acari will be interested in the observations on the behaviour of *Acarus scabiei* made by Dr. Clayton (*Brit. Med. J.*, 752, June 3, 1944) when he placed on the interdigital web between his left thumb and index finger an active female mite. Moving quickly about 1 cm. from the place where it was put, the mite lodged in a furrow of the skin, tilted its body obliquely with the help of its hind-leg bristles and began to bore into the side of the skin furrow. Within a very few minutes "the head and appendages" were buried, but it was 67 minutes before the distal end of the mite had disappeared. J. W. Munro (*J. Roy. Army Med. Coll.*, **33**, 1; 1919) states that, under favourable warm conditions, the mite can conceal itself completely in $2\frac{1}{2}$ minutes. After two full days, the mite observed by Clayton had progressed 0·1 cm. After 24 days the burrow was $\frac{3}{8}$ in. long with perforations in its roof, giving it the typical dotted appearance. In it four translucent eggs were found when it was opened for the removal of the mite. Meanwhile, itching had developed between the middle and ring fingers of the left hand and on the right wrist. A mature female mite was removed from a burrow $\frac{3}{8}$ in. long on the left index finger 34 days after the first mite had begun to burrow. The author does not agree that the posterior direction of the spines of the mite prevent its retrogression out of the burrow and therefore cause its death. He thinks that the spines act as 'pit props' and withstand pressure from the roof and from outside, and help the mite's passage through the skin. There was "strong presumptive evidence" that the eggs of the mite had hatched and that larvæ had migrated and burrowed after slightly less than $5\frac{1}{2}$ days. The author's observations tend to support Monro's statement that the complete life-cycle (egg to egg) varies between $7\frac{1}{2}$ and 13 days.

## Transfusion into the Bone Marrow

IN a paper on transfusion into the bone marrow of the sternum, Hamilton Bailey (see *Nature*, **153**, 258, Feb. 26, 1944) reported favourably on this procedure under certain conditions, and there have been further notes upon this method in the medical literature. Janet D. Gimson (*Brit. Med. J.*, 748, June 3, 1944) now reports on transfusion into the bone marrow of the tibia of infants and young children. The new needle which she has designed for the purpose is figured and described. The technique has been devised because of the difficulty of transfusing into the veins of premature and small infants. The needle is inserted through the flat subcutaneous plate of bone below and medial to the anterior tibial tuberosity well below the epiphysial line of the splinted limb, where there are no important anatomical structures which might be damaged. A photograph of a transfusion in progress is given. Any of the usual transfusion fluids may be given by this method. The constant rate of drip which can be maintained is usually remarkable. The longest time during which one transfusion was maintained was six days, and there was no reason to suppose that it could not have been maintained longer.

## Staining Mammalian Hair

J. Davidson and W. D. Taylor have described (*J. Quekett Micro. Club*, Ser. iv, No. 1, 1943) a technique for the treatment of mammalian hairs so that their structure, more especially that of the cuticular scales, can be studied in detail. Since each species of mammal appears to have its own distinctive hair structure it is easy to see that a means of preparing it for accurate examination may be of importance from the medico-legal point of view as well as for other purposes. The opacity of the medulla in ordinary preparations of hair is shown to be due to the presence in it of air, which can be removed under a vacuum, and not to the presence of pigment. Heavily pigmented hair has next to be bleached, and the formula for a reagent that will do this without injury to the hair is given. The staining is carried out with 1–100 carbol fuchsin (Ziehl Neelson) in a vacuum oven. A series of excellent photomicrographs shows how successful this method is for demonstrating (i) the structure and arrangement of the cuticular scales and (ii) the structure and relative proportions of the cortex and medulla, as shown in optical section, in the hairs of various mammals.

## Enzymatic Adaptation in Yeast

SOME yeasts can ferment galactose whereas others cannot. Of those possessing the ability, some do so only after acclimatization in culture containing the sugar. Some authors claimed that new cells must be formed before the formation of galacto-enzyme occurred, while others suggested that there was a direct cytoplasmic reaction of an original cell. S. Spiegelman, C. C. Lindegren and L. Hedgecock (*Proc. U.S. Nat. Acad. Sci.*, **30**, 13; 1943) have evolved a method by which the reaction of one cell as distinct from that of the population may be followed. It was found that in a haploid population which was presumably heterogeneous, the adaptation to galactose fermentation only occurred after cell divisions, whereas, in diploid-stable populations, this took place throughout the population without the necessity of cell division. A warning is given against the assump-

tion of galactose fermentation taking place when this sugar is the only carbohydrate source for a living yeast colony. Of 34 cultures, only one failed to survive on galactose, but 80 per cent of the cultures were unable to ferment the sugar.

### Genes in Rice

B. S. Kadam and K. Ramiah (*Ind. J. Gen. and Plant Breed.*, **3**, 7; 1943) have listed the inherited characters that have so far been discovered in rice. The number of genes is more than three hundred, and these have been placed under a suitable nomenclature by the authors.

### Synchronous Turbo-Generators

IN a paper (*J. Inst. Elec. Eng.*, **91**, Pt. 2, No. 21; June 1944) on the "Fundamental Electrical Characteristics of Synchronous Turbo-Generators", W. Szwander deals mainly with the MVA. rating or the power factor rating, and with the synchronous-reactance value of large, non-salient-pole machines; and discusses essential factors for selecting these values and a method of making the selection. An analysis is made of the manner in which the two values affect the operation of the generator. From a power chart based on the classical circle diagram, diagrams of 'working area' limitations are derived and represented in co-ordinates of reactive power versus active power, power factor versus active power and excitation current versus active power. These diagrams are suitable for comparing properties of different generators when ordering new units, and for the supervision of operation of generators. Problems of capacitive loads and of synchronous stability of generators are also discussed. From a comparison of external characteristics of an isolated generator, with different load characteristics, conceptions of voltage stability and of 'absolute power limit' in respect of that voltage stability are derived. The author discusses the influence of stator-winding resistance and of saturation on representative diagrams and curves, and illustrates the paper by an example of an actual 50 MW., 58 MVA. turbo-generator.

### Electromagnetic Effects in Solid Iron

IN a paper (*J. Inst. Elec. Eng.*, **91**, Pt. 2, No. 21; June 1944) on "Electromagnetic and Mechanical Effects in Solid Iron due to an Alternating or Rotating Magnetic Field", R. Pohl points out that a problem still awaiting solution is the complete predetermination of the phenomena connected with the penetration of alternating flux into solid iron. The classical expressions for the flux and current distributions and the iron loss due to an alternating magnetomotive force rest on the assumption of constant permeability, and therefore apply only to values of induction far below those now employed. Moreover, they ignore hysteresis, which affects both the loss and the power factor to such an extent as to invalidate these expressions for practical purposes. A further difficulty arises in machine design, in that the magneto-magnetic force acting upon the iron surface forms an unknown component of a known primary magneto-motive force: a second component is absorbed in flux paths outside the iron and depends on the magnitude of the total flux. The paper presents the subject to the designers of electrical machines in a manner with which they are familiar and, in addition to discussing the connexion between the primary ampere-turns and their surface component, shows the effects of hysteresis, and extends the theoretical and experimental investigation to values of induction beyond the knee of the magnetization curve. So far, only the theoretical boundary case of ideal saturation has been solved, and it is shown that a computation based upon a given iron magnetization curve is possible by means of a graphical method. Section 2 of the paper, on practical applications, deals with the utilizable mechanical effects in various types of machines, and indicates means for improving their performance.

### Solar Flares and Magnetic Storms

H. W. NEWTON has continued his work on this subject (*Mon. Not. Roy. Astro. Soc.*, **104**, 1; 1944), discussing the relationship between the less intense flares and geomagnetic activity. The most intense flares of all are denoted by 3+, and, as his earlier paper showed, these proved to be of great importance in the occurrence of great magnetic storms. The present paper is restricted to flares of intensity 3 and 2 in decreasing order of magnitude, and the data for these less-intense flares are almost entirely from the present 11-year solar cycle. Flares of intensity 3 and 2, during 1934–42, are compared with magnetic storms recorded at Greenwich (Abinger), and also with the daily international magnetic character figures (De Bilt). The subject is discussed very fully and is illustrated with the aid of a number of diagrams. In the case of flares of intensity 3, there is a small statistical rise of geomagnetic activity within a few days of the mean flare, but in individual cases the disturbance is generally less intense and is less probable than for flares of 3+. In the case of flares of intensity 2, less than two out of ten flares are associated with a magnetic storm on the day of the flare or one or two days later. This result is very little more than can be expected from pure chance. Fade-outs and magnetic activity are dealt with towards the end of the paper, and the percentage frequency of magnetic storms is plotted against the time-interval in days from fade-out. In a general way the radio fade-out data confirm a small statistical rise of geomagnetic activity within a few days after the mean fade-out. These results are, however, less definite than those from the solar flare data.

### Solar Cycle and Weather

CHARLES G. ABBOT, secretary of the Smithsonian Institution, states that there is close agreement between measurements of calcium flocculi on the sun, made daily by the monks at the Observatory del Ebro, Spain, and changes in the solar constant (*Sky and Telescope*, February). Changes in the solar constant begin two days ahead of changes in the clouds of calcium gas seen on the sun in calcium spectroheliograms. Weather-changes on the earth extend from three days before to seventeen days after the occurrences of the solar changes with which they are correlated. Dr. Abbot finds that for many places the weather features tend to be repeated at intervals of 273 months and still more clearly at double intervals of 546 months, and these characterize the complete cycle of solar constant changes. In addition, the short-interval day-to-day solar variations dominate the weather for many succeeding days. A tentative trial of solar forecasting of temperature departures at Washington for 201 days, based jointly on the work at Ebro and the Smithsonian Institution, gave a correlation coefficient of 59 ± 3 per cent. Dr. Abbot predicts a repetition of the past great North-west droughts in 1975 and again in 2020.

# MAKING AND PRESENTATION OF SCIENTIFIC FILMS

A JOINT meeting of the Association for Scientific Photography and the Scientific Film Association was held at the Ministry of Information on June 24, papers being given by the presidents of the two Associations and by Mr. Geoffrey Bell. Two films were projected, "Control Room" and "Nitrous Oxide-Oxygen-Ether Anæsthesia".

Mr. Arthur Elton, president of the Scientific Film Association, in opening the meeting, welcomed those present on behalf of the two Associations. He said that they could and should be complementary, and that the regions where they overlapped should constitute a strong bond rather than a weakness. He was glad that they were in fact working together and assisting each other materially. To achieve democratic self-government in any country, it is necessary for the citizens to have a knowledge of the scientific processes which govern their lives. The Association for Scientific Photography and the Scientific Film Association are ultimately engaged in public education; while it is not necessarily desirable for everyone to be able to solve a differential equation, the more informed the general public is, the less the danger of its being led away by filibusters such as those who had led away the countries of our enemies.

Mr. Elton then defined the fields covered by the two Associations. The Scientific Film Association, besides seeking to spread the general principles of scientific thought by means of the film, is engaged actively in the more practical problems of the production and distribution of scientific films for the public, and of specialized training films for engineers, chemists, physicists and so forth. The Association for Scientific Photography is concerned with the uses of still photography and cinematography as instruments of scientific research. While the two bodies may appear to be serving separate fields, their functions actually tend to overlap and support each other. For example, a scientific worker might use film in connexion with an investigation, say, for the analysis of high-velocity movements by means of the ultra-speed cine-camera. Sooner or later, he would want to tell people what he had done and therefore to show the film. Unless he was careful his record might well be incomprehensible to all except the specialist. With proper preparation, however, the film could be as useful a method of communication as a published paper. This is where the two Associations overlap most, for they can give advice both on the technique of preparing the film and on its method of presentation and distribution.

Mr. Geoffrey Bell, speaking on "Shooting a Scientific Film", illustrated his talk with "Control Room", a film which was made in Bristol. This shows how the Civil Defence organization works in Great Britain. Though made primarily for American and for general home audiences, the film has also been used for showing to Civil Defence personnel, many of whom did not know how their huge and new organization worked as a whole. The film shows the nature of the technical problems of different branches of Civil Defence and the technique used to achieve co-ordination between these branches. For example, if the telephone engineers and the waterworks engineers want to repair their respective services in the same bomb crater, it is not enough that each should have prepared emergency measures for such a case; there obviously must be co-ordination between the two services. Mr. Bell dealt particularly with the problem of getting this kind of subject-matter converted into film terms. The whole technique of Civil Defence serves in the film as a means of studying the processes of community life, although they are seen in a special light, functioning under the stress of air-raids.

After the film had been screened Mr. Bell pointed out the value of the animated diagram for presenting an abstract process, in this case the procedure by which co-ordination between individual services was achieved through a series of different 'control centres'. He then selected from the film examples of various technical devices and methods of exposition.

One incident was used as typical of the problems of the public services and their relations to the community. The film shows damage to a high-voltage main cable, leaving Avonmouth docks without their normal supplies of electric power. A method of temporary jointing of 33,000-volt cable is shown which takes six hours, instead of the seventy-two hours needed for a permanent jointing. The skill and resource of the electrical engineers is shown to be related directly with the restarting of activity in the docks, and off-loading from ships of essential supplies. Films enable one to show, in a convincing fashion, that detailed aspects of one technical problem can be related with much wider issues affecting the community.

Prof. J. Yule Bogue, president of the Association for Scientific Photography, speaking on "The Production of Scientific Films for Biological and Medical Purposes", divided films into two main groups—those making no new contribution to knowledge but presenting in a suitable form the knowledge at our disposal, and those making a new contribution to knowledge. He then dealt with the former group and followed the making of such a film, from the consideration of its subject-matter for suitability for film treatment, through possible methods of construction, the writing of the script, the photographic techniques involved and the actual shooting of the film, to the cutting, editing and final presentation*.

Prof. Bogue stressed that whether a professional film unit is employed or the film is made by those normally engaged in photography in the department, it was essential to decide all the preliminary work, and to write the complete script, before a foot of film is shot. Although anything scientific implies an orderly presentation of the facts in an objective manner, it is unfortunately true to say that many biological and medical films are neither orderly nor objective although labelled scientific. This is almost always caused by lack of planning and insufficient appreciation of the possibilities of the film.

Prof. Bogue also dealt with the choice of making a film in sound or silent. He believes that, if the worker's or teacher's opinion has to be considered, the film should be silent, but where the film is used to demonstrate a particular scientific discovery or an applied technique by an acknowledged expert in the field, then it should carry a recorded commentary. Having decided this, it is necessary to prepare a full shooting script based on a very clear, short, model lecture manuscript of the subject. Only shots essential to the film should be included, and all camera instructions

* A full report can be obtained from the Secretary, Association for Scientific Photography, Tavistock House North, Tavistock Square, London, W.C.1.

should be clearly given; this requires a full visualization of the finished film while writing the script. When the script is complete, it is highly desirable to send copies to colleagues in the same field for their comments. This usually improves a film very much; it should be noted, however, that two or three outside critics are sufficient and a committee should be avoided.

After a full discussion of the technical details of the filming and of the apparatus used, Prof. Bogue stressed the need for keeping the original film intact and employing a duplicate for cutting and editing, particularly when "Kodachrome" is used. The script should be broken down into shots, each on an index card with full technical information; the editing can then be carried out largely from this file. This is, of course, the stage at which the film is made or spoilt. The best films demand good presentation if they are to be used successfully. A good-quality projector and screen, suitable for the size of hall and audience, are essential.

After the screening of "Nitrous Oxide-Oxygen-Ether Anæsthesia", there was a discussion which ranged over detailed problems of technique in film making, as well as wider issues regarding the production and use of scientific films. Among the matters discussed were the illumination most suitable for the photographing in colour of fatty tissues, and the desirability of making films on specialized subjects about which there might be controversy.

# TECHNICAL EDUCATION IN THE U.S.S.R.

IN a paper read at the fiftieth annual meeting of the Society for the Promotion of Engineering Education (United States), which has recently been published, J. G. Tolpin, of Universal Oil Products Co., described the progress of technical education in the U.S.S.R. up to the end of the third Five-Year Plan in 1942, with special reference to the engineering industries. It is a record of great achievement in the face of many difficulties, and may be viewed as both cause and effect in an unprecedented industrial expansion since 1914; especially since 1931, when Stalin said that Russia was still fifty to a hundred years behind the world's leading nations, and would have to make up this lag in ten years.

In 1914, manufacturing industry was only about one-twelfth its present size, and the whole country was still mainly agricultural. Moreover, the full extent of her vast natural resources was very inadequately realized compared with the knowledge now acquired by research and exploration. For example, it has now been discovered that the reserves of potassium minerals in Kazakhstan are the largest in the world; and the coal seams of the Pechora region are now estimated at 120,000 million tons. These and many other new discoveries of mineral wealth have meant corresponding developments in industrial activity and consequently an ever-increasing and more urgent need for trained and well-educated workers. The following figures indicate some of the progress made since 1913:

| | 1913 | 1937 | 1942 |
|---|---|---|---|
| Coal output (mill. tons) .. .. | 29·1 | 128 | 230 |
| Iron ore ,, .. .. | 9·2 | 27·8 | — |
| Oil (mineral) ,, .. .. | 9·1 | 28·4 | 48·5 |
| Sulphuric acid (1,000 tons) .. .. | 121 | 1,666 | — |
| Electrical energy (bill. kWh.) .. | 1·9 | 36·4 | 75 |
| Locomotives .. .. .. .. | 664 | 1,214 | 2,090 |

In this period the agricultural population, which represented 80 per cent of the whole in 1913, fell to 55·5 per cent of the total in 1939; or, in other words, the non-agricultural wage earners numbered 28 millions in 1938 as compared with 11·2 millions in 1913; total population increased to 170·5 millions in 1939. Industrial output has been stimulated not only through the ordinary channels of better trained workers, but also by special methods and incentives, including the distribution of medals and other decorations for specially good work, mention in the general and technical press, and by other means: at the same time poor results due to bad management or otherwise are equally publicized. The total number of youths of 14–17 at present being mobilized for industrial training is nearly 1,000,000. After preliminary training they will work for four years on State enterprises. In the case of these and possibly other groups, it is said that special inducements are being offered to encourage them to attend the factory technical schools rather than the college grade schools, as the latter do not, it is alleged, turn out quite the right type of skilled workers for industrial plants. In the U.S.S.R., therefore, the old problem met with in other countries of striking a judicious balance between academical and practical or shop training also presents difficulties.

Looking at this matter of technical education and training in more detail, it may be said that the general school organization in the U.S.S.R., like other things in the social system, undergoes constant change, so that, as Tolpin points out, the latest official publication (1940) on school regulations is nearly all new. An important factor in this gradual evolution of the educational policy was the national convention of professors and administrative officers in May 1938, in the Moscow Kremlin, which was attended by Stalin himself. V. M. Molotov then stated that the number of students in college grade schools exceeded the combined figures for Germany, England, France, and Italy, but neither the quantitative nor qualitative objectives had been reached. The total enrolment in all types of schools in 1939 was 34 millions, of whom 600,000 studied in college grade schools. It would scarcely seem that this latter figure is an excessive proportion of the whole, or needed special efforts for its further reduction. There are no sex distinctions, and the Revolution opened all schools equally to men and women, of which the latter seem to have taken full advantage. They are now active in every field of technical and professional work and in all branches of social research. In 1939 sixty per cent of all physicians were women, and in the Bashkir country the percentage reached 75. Many of them are directors of research in medicine and other sciences, pure and applied. Women formed more than 41 per cent of the total of college students in 1939, and 27 per cent in the technical (factory) schools. The most marked advance in this respect has been in the Moslem countries (for example, Uzbekistan and Turkmenia), as might be expected, since in such countries women had much further to travel along the paths to emancipation than in others.

Nor is any distinction made in regard to national minorities or in the numerous parts of the Soviet Union where the native language is not Russian, such as the Ukraine, Georgia, Armenia, White Russia, and parts of Siberia. There are more than a hundred different languages and dialects altogether in the Union, of which more than sixty are recognized for use in public institutions. Many newspapers and

technical journals are printed in these languages, and Russian itself is merely one of the more important subjects of instruction in the schools.

In the early years after the Revolution, schools for adults formed an important part of the Russian educational system, and were strongly supported by the State. Adult students numbered 320,000 in 1932; but the numbers are, of course, gradually declining, as the younger generation, much better educated than its forbears, is growing up. Among all classes of the population—old and young—there is a zeal and keenness for education, stimulated by the teachings of Lenin and other early leaders; but for some time there was a serious lack of suitable teachers. In 1939 the number of professorships or chairs was about 10,000, more than half of which were held in the technical and agricultural colleges; while the total teaching staff was a little more than 40,000. Education is mostly entirely free, and some 90 per cent of the students of college grade schools receive grants.

Special attention is, of course, devoted to vocational training, and the aim is to give at least a minimum of technical training to every worker, including labourers. The Five-Year Plan ending 1942 called for the training of more than 9 million persons for work in industry in different capacities. The technical schools in the Soviet Union, in addition to the higher college grade schools or universities, include also the 'technicums' or secondary technical schools. In 1938 there were in existence 3,400 of these, and it was expected that the number of students would reach 800,000 in 1942. For admission to a 'technicum', seven years of preliminary schooling is required, as compared with ten years for the college grade school; and the course lasts four years.

The factory schools fulfil important functions in training qualified workers. They were reconstituted in a different form in 1940. During the first Five-Year Plan these schools trained 450,000 workers; treble that number during the second; and the number planned for the third was 1,700,000. In addition to purely vocational training, they give a certain amount of general and political education, and also special training designed to meet the needs of any particular industry.

Special facilities, largely controlled by the Committee for Higher Education in Moscow, are provided for a first-class engineering training for students who have taken the general courses in secondary schools and have reached the age of 19–20. These are available either in the universities or technical colleges, and extend over five years, with examinations every year. The programme of study comprises almost the same basic subjects as those of engineering schools in other countries, with a few exceptions. In the case of non-Russian students, ample provision is made for the study of Russian for the first two years, the time being taken out of that allotted for foreign languages. Social and economic science and philosophy are included, with particular reference to that of the Communist Party. Parenthetically, it may be remarked that this philosophy is not necessarily the same as it was in the early days: one of the points most strongly emphasized by Lenin was that social philosophy must be constantly subject to change and evolution, and this appears to have been confirmed in the recent history of the Soviet Union. In regard to foreign languages, it is interesting to note that, until lately at all events, English was the foreign language to be studied by petroleum engineers, whereas German was preferred for mechanical engineers.

Special efforts are made to provide sufficient numbers of the right kind of fully trained teachers for the engineering courses; and no money is spared in buildings and equipment, in facilities for research, and so forth. More attention also is now being given to the matter of patents for invention, with the view of making the patent system a more effective means of encouragement in developing the inventive skill or genius of students. Employment bureaux are an essential part of the organization, but their chief difficulty is that there are always more positions open than applicants to fill them. The 150,000 young engineers and scientific agriculturists trained in more than two hundred technical colleges during the third planned period were certain to be less than the number required. Provision is also made for post-graduate work and preparation for D.Sc., D.Ph. and other degrees. In view of the shortage of trained men just mentioned and the vast programme of rebuilding, etc., at the end of the War, it is thought there may be scope and opportunity for collaboration with British and American engineers, and no doubt this is already under careful consideration in the right quarters.

## NATIONAL RESEARCH COUNCIL, CANADA

THE twenty-sixth annual report of the National Research Council, Canada, 1942–43, includes the report of the president together with the reports of the directors of the Divisions of Applied Biology, Chemistry, Mechanical Engineering, Physics and Electrical Engineering, of the Section on Codes and Specifications and of the Research Plans and Publications Section. Owing to war-time requirements, publication of the "Review of Activities" has been discontinued temporarily. The National Research Council is now serving as a central co-ordinating body directing scientific research in Canada, within its own laboratories, in the universities and in industry, and the Council has been appointed the official research station of the Navy, Army and Air Force in Canada.

With the exception of a long-term project on forest-tree breeding, the work in the Division of Applied Biology is now wholly related to the war effort. The pre-war staff of nine has been increased to twenty-nine to cope with the food problems submitted by various Government departments. Investigations on modified curing practices have led to the adoption of a standard cure, with the result that Canadian bacon is now held in higher favour on the British market than ever before, and even under war-time conditions of transport and storage the proportion of Canadian bacon de-graded by the British Ministry of Food is so exceptionally small that rigorous inspection is no longer considered necessary. Studies on egg-shell treatment to extend the storage life of eggs under the storage and transport conditions of war-time have been completed and large-scale investigations undertaken to determine the best conditions applicable in industry for processing and storing dried eggs. Standard canning procedures in line with the Council's findings have been adopted by manufacturers of canned pork and ham, and a laboratory method has been developed

for processing Irish moss. Work is being continued to find a commercial method for preparing a good gelling substance from this seaweed. Work has been undertaken on improvement of the stability and other properties of lard as a suitable alternative for other vegetable oil shortenings. A survey was made of the vitamin intake of Canadian Army troops garrisoned at district depots, and much work has been done on the development of substitutes for metal containers with special reference to the packaging of dehydrated foods for export or Army use. The Fermentation Section's staff has been increased from four to fourteen members, and much of the time of the Section has been devoted to the study of the manufacture of butylene glycol from wheat by a fermentation process. Pilot plant is under construction.

In the Division of Chemistry, research on photosensitized reactions has continued, but experimental alkaloid research has been on a reduced scale. Fundamental investigations on the chemistry of leather and plastics have continued, and that Section has been considerably enlarged to take care of the test work required by the Armed Services and Inspection Board. The laboratories of the Textile Section were occupied chiefly with defence work involving investigations on substitute materials and preparation of purchase specifications, acceptance tests and fundamental research on problems arising out of war uses of textiles. The Paint Laboratory has been occupied to an increasing extent with the needs of the Services for special paints, lacquers, protective coatings, shell-filling material, anti-freezes, etc. The Rubber Laboratory has given special attention to the study of rubber substitutes and synthetic rubber.

In the Division of Mechanical Engineering, all work having no bearing on the war effort has been suspended or abandoned. Installation of the driving and controlling equipment of the horizontal wind tunnel has been completed, and calibration and adjustment of the vertical spinning tunnel are proceeding. The staff of the Division of Physics and Electrical Engineering has been further increased, and, as before, the bulk of the investigations have been of a secret nature and not at present suitable for publication. The General Physics Section has been engaged largely on naval work, ballistics and the design of fire-control gear, as well as on the development of equipment for one phase of anti-submarine warfare. Work in the Optics Section has involved research and development in optical instruments, photography, spectrochemical analysis and geometrical optics as well as the making of a large number of optical components of military instruments in the optical shop.

The Section on Codes and Specifications has been restricted during the War to a maintenance basis in respect of its two main branches—the National Building Code and the Canadian Government Purchasing Standards Committee. The Research Plans and Publications Section, which is responsible for the conduct of the National Research Council Library, refers to the increasing use of the Library, to its bibliographic work and literature searches, technical inquiry work and the issue of the *Canadian Journal of Research*.

Other details of the war work of the Divisions are included in the president's report, which also gives a survey of extra-mural activities of the Council. Among these may be specially mentioned the Service committees established under the Associate Committee on Medical Research to deal with Aviation Medical Research, Naval Medical Research and Army Medical Research. The first has carried out an impressive programme of work in the fields of high-altitude flying, protective clothing for flyers, oxygen equipment and in special studies relating to personnel selection. The second, in addition to dietary surveys in vessels under operating conditions and in shore establishments, has carried out experiments on the use of vitamin A to improve night vision. Special lighting techniques designed to minimize interference with night vision have been devised for use on bridge controls, bridge instruments and chart tables. Special tests elaborated for the evaluation of night vision, colour vision, and visual acuity have been adopted by the Navy, while experimental work on fatigue of personnel operating anti-submarine detection devices has yielded information which has been applied in determining the watch period to be used for this work. Other investigations have covered under-water blast injury, eye-protection for bridge and look-out personnel, obtaining fresh water from sea-water in lifeboats, protection of naval personnel from noise, combating fatigue in radio detector and wireless operators, and sea-sickness problems. Another war-time committee of the Council has co-ordinated and directed research in Canadian universities on sixty projects concerned with the production of explosives now in use and the development of new explosives.

## THIRD ANNUAL MEETING OF THE ANTI-FASCIST SOCIETY OF SOVIET SCIENTISTS

By VICTOR KRASILNIKOV*

PROMINENT representatives of Soviet science attended the third meeting of the Anti-fascist Society of Soviet Scientists held in Moscow on June 18. In his opening remarks, the president, Derzhavin, reminded his audience of the solemn oath taken by them at their first meeting in the memorable days of October 1941 when the German Army was driving on to the capital of the U.S.S.R. They then vowed to devote all their energy and knowledge to the war effort of the nation. Soviet men of science, he said, have kept that vow.

An eloquent speech was made by the vice-president of the Academy of Sciences, Alexander Baikov. He gave an account of the great contributions of Soviet men of science to the war effort. Metallurgists have speeded up existing processes of production, and introduced important improvements in the technology of iron and steel production. Geologists have discovered new deposits of manganese, mercury, lead and petroleum. Botanists have investigated new varieties of medicinal herbs and vitamin-yielding plants. Agricultural scientists have helped to increase crop-yields. Medical scientists have shown numerous examples of self-sacrificing service to their country.

Prof. Peter Kapitza, of the Academy of Sciences, remarked that since the second meeting of the Society, in July 1943, many stirring and cheering events have taken place. But, while rejoicing at the Army's advance, in the course of which Russian territory is being liberated from the hands of the

* Transcribed and prepared by A. Clifford.

invader, scientific workers cannot but be deeply pained by the damage which the enemy is inflicting on the country. "We scientists have reason to feel gratified by the fact that we have been able to help, with our knowledge, to improve the armaments of the army, and to facilitate the struggle against German barbarity."

The audience listened with great interest to the speech delivered by Prof. Maria Petrova, of Leningrad. She remained in Leningrad all through the siege. "It was painful," she said, "to see how German artillery destroyed the scientific and public institutions of the city, but I never for one moment lost faith that the enemy would be defeated. Work was the best answer to the crimes of the barbarians. During the siege I completed twelve scientific investigations."

Igor Grabar told of the appalling destruction by the Germans of monuments of Russian art in Novgorod and in the environs of Leningrad. Prof. P. V. Pavlov, of the University of Odessa, who lived in that city during its occupation by Germans and Rumanians, and Prof. Alyoshin, of the University of Kiev, who likewise saw all the horrors of German occupation, spoke of the damage done by the invaders to scientific and cultural institutions in the Ukraine. This was also the subject of a speech by Alexander Beletsky, of the Ukrainian Academy of Sciences.

Nikolai Nikolsky, member of the White Russian Academy, told the meeting of the 'new order' in German-occupied Minsk. This elderly grey-bearded scholar escaped from Minsk with the aid of White Russian partisans in August 1943. He had spent seven months with a partisan detachment, and only in April 1944 made his way to the "mainland", as partisans call Soviet territory across the front line. Prof. Krisciunas spoke of the plight of the intelligentsia in German-occupied Lithuania. Nikolai Propper-Grashchenkov, corresponding member of the Academy of Sciences, denounced the practices of German physicians. He said that the Soviet medical profession is in possession of irrefutable proofs of the participation of representatives of German science in the killing of prisoners-of-war and of mentally diseased people, and in the bleeding of Soviet children for blood transfusions to such an extent that the children died. They also have documents showing that German surgeons carried out experimental operations on prisoners-of-war.

Alexander Poraj-Koszyc, another member of the Academy, made an inspiring speech in which he called upon the scientific and professional men of Poland to devote all their efforts to the defeat of Hitlerism.

Many messages of greeting were received from various institutions as well as from private individuals in the Soviet Union and abroad. The meeting enthusiastically adopted the text of a message of greeting to the Commander-in-Chief of the Armed Forces of the U.S.S.R., Joseph Stalin, and issued an appeal to men of science throughout the world. This appeal said, among other things: "Fascism is the most malignant foe of science and culture. . . . There is only one way to save human beings and cultural treasures, and that is, to defeat Germany and her satellites at the earliest possible date. . . . All of us must take an active part in this struggle. Let every intellectual and every scientific worker who is not fighting 'arms in hand' contribute his mite to the common cause of humanity by intense creative effort."

# EARTHQUAKES IN SOUTHERN CALIFORNIA

BENO GUTENBERG and C. F. Richter have recently studied in detail several hundred earthquakes in southern California with the view of finding out the physical properties of the earth's crust in the region. The first paper under discussion, "Recent Results of Earthquake Study in Southern California", by both authors (*Trans. Amer. Geophys. Union*, 1943) contains first the travel-time equations of the district. These are:

$$\bar{P} - 0 = D/5{\cdot}577 \qquad \bar{S} - 0 = -0{\cdot}5 + (D/3{\cdot}26)$$
$$Py - 0 = 1{\cdot}2 + (\Delta/6{\cdot}05) \qquad Sy - 0 = 2{\cdot}0 + (\Delta/3{\cdot}64)$$
$$Pn - 0 = 6 + (\Delta/8{\cdot}06) \qquad Sn - 0 = 8 + (\Delta/4{\cdot}46)$$

where $\Delta$ is epicentral distance in km. and $D$ is hypocentral distance for focal depth of 18 km.

The authors state that the terms independent of $\Delta$ in the equations for $Pn$ and $Sn$ show appreciable variation for shocks in different parts of the region, with maxima of about 9 and 13 respectively in the shocks of northern Owens Valley east of the Sierra Nevada. This is an effect of the 'root' of the Sierra.

The travel-times indicate no variation in the thickness of the 'granitic' layer, which is about 18 km. Most of the shocks originate near the base of this layer. There is at least one 'intermediate' layer between this and the base of the continental crust (the Mohorovičić discontinuity). The velocity of $Py$ in this layer differs notably from that of the similar wave $P^*$ as observed in Europe (6·05 instead of 6·4 km./sec.). If this is a single layer, its thickness varies from about 20 km. in the coastal area to almost 50 km. in the Sierra region.

The term $-0{\cdot}5$ in the equation for $\bar{S}$ represents a frequently noticed discrepancy between the apparent origin-times of $\bar{P}$ and $\bar{S}$. The writers attribute this to development of the fault-fracture with speed greater than the velocity of transverse waves, resulting on the average in early arrival of $\bar{S}$ at the observing stations. The following are mean values of elastic constants (C.G.S. units) from all available data for the region:

| Layer | Bulk-Modulus | Rigidity | Poisson's Ratio |
|---|---|---|---|
| Granitic | $4{\cdot}5 \times 10^{11}$ | $2{\cdot}9 \times 10^{11}$ | 0·24 |
| Intermediate | $5{\cdot}5 \times 10^{11}$ | $3{\cdot}8 \times 10^{11}$ | 0·22 |
| Below Intermediate | $12{\cdot}4 \times 10^{11}$ | $6{\cdot}5 \times 10^{11}$ | 0·28 |

J. M. Nordquist is in the course of developing a new application of the magnitude scale in association with these earthquakes. Assuming a special distribution function already employed by E. J. Gumbel in the investigation of flood-statistics ("Statistical Control-Curves for Flood-Discharges." By E. J. Gumbel, *Trans. Amer. Geophys. Union*, 489–509; 1942) makes it possible to choose a scale for a plot in which the points for various magnitudes fall nearly on a straight line, the level of which is an indication of the degree of activity. This method promises a quantitative definition of seismicity.

The second paper here discussed is "Variations in Physical Properties within the Earth's Crustal Layers", by Beno Gutenberg (*Trans. Amer. Geophys. Union*, 1943). In it the author states that the travel-times as well as the amplitudes lead independently to the conclusion that most of the fifty shocks discussed in this second paper originated at the bottom

of the Granitic layer. In shocks with faulting completely inside the Granitic layer only, the amplitudes of $Py$ should be about the same as those of $Pn$. The fact also that the amplitudes of the various $S$ waves change with distance in a similar way to those of the corresponding $P$ waves indicates that the effect of pressure and temperature on the coefficient of rigidity is relatively the same as on the bulk-modulus.

Gutenberg states that the Mohorovičić discontinuity is at a depth of about 35–40 km. in the coast areas of southern California, but deeper under mountain ranges. The velocity of $Pn$ below it is close to 8·0 km./sec. At first, the velocities of both $P$ and $S$ increase with depth, probably at a rate similar to that in the upper layers; but the rate of increase falls off rapidly with increasing depth, resulting in a rapid decrease of the amplitudes of $Pn$ and $Sn$ with distance beyond $\Delta = 200$ km. Amplitudes of $Pn$ and similarly of $Sn$ in intermediate shocks without appreciable surface waves, on records of shocks originating at various depths within a radius of about 2,000 km. from Huancayo, Peru, and recorded at the station there, confirm results obtained previously by Gutenberg and Richter concerning the relationship between the epicentral distances at which the amplitudes of $Pn$ are very small, and the focal depth of the shocks.

These findings, according to Gutenberg, can be explained on the assumption that at a depth of about 80 km. the melting point of the material is reached. Immediately above that critical depth, the effect of temperature on the bulk-modulus and on the coefficient of rigidity may approach, or even surpass, the effect of pressure. At the critical depth itself, there may be a slight sudden decrease of the wave-velocity. At greater depth, the effect of the temperature on the bulk-modulus and the coefficient of rigidity becomes more and more insignificant. Whereas above the critical depth a certain minimum stress, the strength, is required to start plastic flow, below this depth no appreciable strength exists, and the plastic flow is controlled only by the viscosity of the material.

## FORTHCOMING EVENTS

### Saturday, August 19

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at Austria House, 260 Oxford Road, Manchester), at 7.30 p.m.—Dr. E. Broda: "Science in Austria (with special reference to the 100th Birthday of L. Boltzmann)".

### Tuesday, August 22

QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Exhibition of specimens and discussion.

## APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SPEECH THERAPIST (whole-time)—The School Medical Officer, County Hall, Chichester (August 23).

ASSISTANT MASTER preferably with Graduate or equivalent qualifications in Engineering, mainly for work in the Junior Technical School—The Acting Secretary to the Education Committee, 1 Eastbank Street, Southport (August 23).

ASSISTANT PSYCHOLOGIST in the School Psychological Service—The Director of Education, Education Department, Newarke Street, Leicester (August 25).

GRADUATE TEACHER OF ENGINEERING (full-time) for Day and Evening Classes in the Crewe Technical College—The Director of Education, County Education Offices, City Road, Chester (August 25).

LECTURER IN AGRICULTURAL ZOOLOGY, including ENTOMOLOGY, and an ASSISTANT ADVISORY OFFICER IN ANIMAL HUSBANDRY—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (August 25).

PRINCIPAL OF THE BURNLEY MUNICIPAL COLLEGE—The Director of Education, Education Offices, Burnley (August 26).

ASSISTANT IN BOTANY—The Secretary, The University, Aberdeen (August 28).

ADVISER IN AGRICULTURAL ENTOMOLOGY (temporary)—The Registrar, King's College, Newcastle-upon-Tyne (August 31).

ASSISTANT LECTURER IN ENGINEERING—The Registrar, The University, Manchester 13 (August 31).

LECTURER IN GEOGRAPHY—The Secretary, University of Durham, 38 North Bailey, Durham (September 1).

BOROUGH ENGINEER AND SURVEYOR to the County Borough of Southampton—The Town Clerk, Town Clerk's Office, Civic Centre, Southampton (endorsed 'Borough Engineer and Surveyor') (September 4).

BOROUGH ENGINEER AND SURVEYOR—The Town Clerk, Town Hall, West Ham, London, E.15 (endorsed 'Borough Engineer and Surveyor') (September 4).

LECTURER IN PHYSIOLOGY—The Secretary, The University, Birmingham 3 (September 5).

UNIVERSITY READERSHIP IN PHYSICS tenable at King's College—The Academic Registrar, University of London, South Kensington, London, S.W.7 (September 6).

CHAIR OF MINING—The Acting Registrar, The University, Leeds 2 (September 30).

LECTURER IN PHILOSOPHY—The Very Rev. the Dean, Christ Church, Oxford (October 15).

HYDROGRAPHICAL SURVEYOR for the Basrah Port Directorate, Iraq—The Ministry of Labour and National Service, Appointments Department, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. O.4962S).

SCIENTIFIC OFFICER (man or woman, temporary) in the Cod Liver Oil (Poultry) Standardisation Laboratory—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks.

SPEECH THERAPIST (full-time)—The Secretary for Education, Education Offices, York.

LECTURER (man or woman, full-time, temporary) IN BIOLOGY in the Leeds College of Technology—The Director of Education, Education Offices, Leeds 1.

LECTURER (woman) IN MATHEMATICS AND BIOLOGY (Nature Study) OR GEOGRAPHY in the Swansea Training College for Women—The Director of Education, The Guildhall, Swansea.

## REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

Metallurgical Abstracts (General and Non-Ferrous). Vol. 10, 1943 (New Series). Edited by N. B. Vaughan. Pp. xii+523. (London: Institute of Metals.) [257

Medical Research Council. War Memorandum No. 3: Economy in the Use of Drugs in War-Time. Revised second edition; with an Appendix on Economy in the Use of Bactericides. Pp. 16. (London: H.M. Stationery Office.) 3*d*. net. [257

Some Recent Advances in Chemistry in relation to Medicine. By Dr. D. H. Hey. Pp. 24. (London: Royal Institute of Chemistry.) [257

National Veterinary Medical Association of Great Britain and Ireland. Publication No. 6: Report on Diseases of Farm Livestock, Section 2: Diseases of Sheep. Pp. 101. 10*s*. Publication No. 7: Memorandum on Farm Buildings. Pp. 48. 5*s*. (London: National Veterinary Medical Association.) [257

Ministry of Food. Insect Pests of Food. 1: The Larvæ of the Lepidoptera associated with Stored Products, by H. E. Hinton; 2: Keys for the Identification of the Lepidoptera infesting Stored Food Products, by A. S. Corbet and W. H. T. Tams. Pp. 144+5 plates. (London: H.M. Stationery Office.) 5*s*. net. [257

British Association for the Advancement of Science. Report of Committee on Post-War University Education. Pp. 52. (London: British Association.) 2*s*. 6*d*. [267

Transactions of the Royal Society of Edinburgh. Vol. 61, Part 1, No. 6: Growth Stages in some Jurassic Ammonites. By Dr. Ethel D. Currie. Pp. 171–198+1 plate. (Edinburgh and London: Oliver and Boyd.) 7*s*. 6*d*. [277

### Other Countries

League of Nations: Economic, Financial and Transit Department. Food Rationing and Supply, 1943–44. (Publication: 1944: II.A.3.) Pp. 101. (Geneva: League of Nations; London: George Allen and Unwin, Ltd.) 4*s*. 6*d*. [257

Annals of the New York Academy of Sciences. Vol. 45, Art. 7: The Distribution of the Salamanders of the Genus *Plethodon* in Eastern United States and Canada. By Arnold B. Grobman. Pp. 261–316. (New York: New York Academy of Sciences.) [257

Proceedings of the American Philosophical Society. Vol. 87, No. 5 (May 5, 1944): Papers on Archæology, Ecology, Ethnology, History, Paleontology, Physics, and Physiology. Pp. iii+365–460. (Philadelphia: American Philosophical Society.) [257

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 178: Food Composition Tables. Compiled by Hedley R. Marston and Mary C. Dawbarn. Pp. 104. (Melbourne: Government Printer.) [257

U.S. Office of Education: Federal Security Agency. Leaflet No. 69: Education in China To-day. By C. O. Arndt, Severin K. Turosienski and Tung Yuen Fong. Pp. 12. 5 cents. Vocational Division Leaflet No. 13: Professional Nurses are Needed. (Revision of Leaflet No. 10.) Pp. vi+30. 10 cents. (Washington, D.C.: Government Printing Office.) [257

U.S. Department of Agriculture. Technical Bulletin No. 846: The Cabbage Looper as a Pest of Lettuce in the Southwest. By K. B. McKinney. Pp. 30. (Washington, D.C.: Government Printing Office.) [257

# NATURE

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CONTENTS




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## SCIENTIFIC AND INDUSTRIAL RESEARCH.—I

WHILE there is no interruption to the flow of reports and papers discussing scientific and industrial research—the statements "A Post-war Policy for Science" issued by the Association of Scientific Workers and "Problems of Scientific and Industrial Research" from Nuffield College are among the more recent—there is some reason to fear that even from the point of view of educating public opinion as to what is required, many of the contributions to this discussion are not so effective as they might be. One of the main reasons is that discussion, not to say opinion, is becoming confused because of the failure to distinguish clearly between tactics and strategy. Admittedly the distinction is not always easy to maintain in practice, but it is all the more important that the effort should be made at a time when the short-term and long-term aspects of these problems may vary considerably in urgency. Unless our broad objectives are clearly seen and defined in terms both of programmes and in respect of the type of men required to serve them, there is grave danger that steps may be taken to meet our short-term needs which may prove serious obstacles to the more fundamental developments which are also required.

There is yet another reason for distinguishing clearly between the tactics and the strategy of research which is well illustrated in the Nuffield College statement. Welcome as may be the large measure of agreement on what are clearly matters of tactics, such as the encouragement of mobility in research workers, on their status and remuneration and general improvement in conditions of service, such matters depend on, and may even determine, the nature of the institutions or organization which we set up for research. Unless, therefore, we have first resolved on the broad lines of our research programmes and on the qualities which they will demand in the personnel responsible for their execution, apart from the corresponding demands for material resources such as equipment, we cannot determine the appropriateness of either institutions or organization to serve our purposes. Attention to tactical questions before strategic objectives have been decided may thus very well create obstacles to the strategy of research which will not easily be overcome.

There is a further reason why the distinction between strategy and tactics is important, and this is well illustrated in the statement from the Association of Scientific Workers. The decline of German science since 1933 is sufficient evidence that science cannot ignore political institutions, that, even from the point of view of the advance of science itself, some regard must be had to the social and political institutions affecting the conditions under which the man of science works. Society has an effect on the course of science which may not be so obvious, but may be as pronounced, as the impact of science on society. Not only are scientific workers increasingly concerned

with the social effects of the application of scientific discoveries, with seeing that the knowledge which in such fields as nutrition, for example, has made possible the improvement of health and elimination of disease, is used effectively, but also they are conscious that the structure of social institutions and of industry may markedly assist or impede such processes.

With such considerations increasingly prominent, the difficulty of handling aright the problems which arise out of the interactions of science and society and politics becomes more acute. It is more than ever important, as it becomes more difficult, to draw the line and determine exactly how far and in what manner science should make its representations in political affairs where scientific factors are specially important. Uncertainty of touch or judgment in such matters as, for example, in the statement from the Association of Scientific Workers, is a fatal obstacle to handling these problems wisely and shaping aright the organizations through which may best be expressed the voice of science in the fields where it has a legitimate and imperative right to be heard.

One of the main reasons for failings in this respect is the absence of enough attention to the philosophy of research, and the symposium on the "Organisation, Direction and Support of Research" arranged last autumn by the American Philosophical Society (see p. 263 of this issue) is a notable contribution to the fundamental thinking required, here and on the larger strategy of research, before we can consider in detail those questions of tactics with which much current discussion in Great Britain has been overburdened. The long paper by H. A. Innis on "Political Economy in the Modern State" contributed to that symposium is particularly suggestive in this connexion, and a welcome correction alike to the tendency to align science with any particular political party or system or to those who imagine that science can remain indifferent to the political institutions which determine the limits within which freedom of scientific thought and inquiry are possible. He directs attention to exactly those problems which must be solved in the control of research, whether by the State or by industry, if the creative spirit is to be preserved and if freedom of inquiry is to mean advance in knowledge and not the mere acquisition of information which may or may not be relevant to future intellectual progress or to society's needs.

Recognition that the distinction between fundamental and applied research is merely a convenience which can be overstressed should at least help the consideration of the conditions which are fundamental for fruitful research of either type. In many fields, as the Nuffield College statement points out, the distinction has little meaning. Both methods are constantly being used simultaneously in attacking a problem ; they are interdependent, advance in one constantly affecting the other. No clearer demonstration of this could be found than in the recent offer of the directors of Imperial Chemical Industries, Ltd., to provide eighty fellowships in science at nine universities in Great Britain, in connexion with which Lord McGowan stated, "Nearly three generations of experience of the administration and conduct of research have convinced us that academic and industrial research are interdependent and complementary and that it is useless to expect substantial advances in industry without corresponding advances in academic science". Clearly, therefore, if we can determine and establish the conditions under which fundamental research or investigation concerned purely with the advancement of scientific knowledge is best promoted, we shall have gone far to determine those under which applied research also will flourish, and this irrespective of any particular branch of scientific inquiry. We cannot, however, rest content merely with postulating a free society and freedom of inquiry. The research worker must be free both from intimidation and from control by government ; he must be able to inquire and speculate with as few restraints as possible : but the debate between the protagonists for absolute freedom in science and those who advocate the maximum planning of science will lose some of its value if it fails to emphasize the positive as well as the negative side. We are concerned with factors which stimulate, as well as with avoiding restrictive or repressive conditions. We must seek for conditions which stimulate creative powers, imagination and enthusiasm, and beware of checks on them as well as on the scope or direction of inquiry.

There is yet another point at which conditions of scientific work are affected, if not determined, by the nature of the society in which the man of science works. A totalitarian regime clearly is inconsistent with full freedom of scientific inquiry and ultimately fatal to the advance of knowledge, but other political systems may have their own effects through their influence on the various types of incentive—social as well as economic—which summon the scientific worker to give of his best. Dr. J. B. Conant made a wise point in his address to the American Philosophical Society's symposium when he referred to the importance here of the quality of the appeal to the brilliant and enterprising sons and daughters of the mass of our society. That appeal, he thinks, should be couched neither in utilitarian terms nor in those appropriate to the secluded retreat, but rather that in each area of the entire field of learning the activities under way must be manifestly relevant to the future of our civilization, not only to man's physical and social needs but also to his highest hopes and aspirations.

The relations of science to society and even to industry are in fact more complex than some of the more ardent protagonists of planning care to admit, and Dr. Conant's suggestion of relevance rather than utility as the touchstone to test the vitality and validity of a scholarly enterprise indicates a line of thought to be explored more fully. Again, the limitations of the scientific method as applied to social problems, the looseness with which the term is employed, to which Dr. Conant directs attention, equally merit consideration, as much as the greater emphasis on philosophy for which he calls. It is the

absence of an adequate philosophy and consequent failure to develop the capacity for making disciplined and well-informed judgments on all those matters of value which are involved in so many vital human decisions that has been responsible for the weakening of civilization and the growth of barbarism. From no point of view can we be satisfied any longer with a system of education that fails to develop that capacity. It must be one of the prime requirements in future of all our training institutions, both for teaching and research, and we should vigilantly watch to see that no subsequent organization impairs or retards that same capacity of judgment.

Dr. Conant has assuredly put his finger on the weak spots. It is not that high standards of performance as to the technical part of his task are not essential for the scholar whether man of science, mathematician, philosopher or historian. Equally essential, however, are integrity of purpose, a disciplined imagination, and the power of critical analysis of both the problem at hand and the investigator's own contribution. To provide such men and women who come into the court of public opinion with clean hands and a consecrated heart, and to maintain their integrity and consecration and critical and imaginative powers undimmed, should be a first objective of our research strategy. The institutions and organization which can succeed in this will never lack the flow of creative thought and fundamental discovery upon which the advancement of science and of civilization both depend.

There are therefore at least two problems involved here. First re-examination of our whole educational system, not merely at the university level, with respect to the provision of an adequately trained and broadly educated personnel to enter the field of scientific research, and the balancing of the immense needs for technical and scientific training by competent education in the liberal arts and humane studies. The emphasis must be on the balance, for the second problem is that of securing competent direction of research. That is no less vital. It forms the link between the two things which, as the Goodenough Report on Medical Schools points out, a community that wishes to promote research must do. "First and foremost, it must find and train the men who have the ability and impulse for scientific inquiry. Secondly, it must create the most favourable conditions for their work and give them the tools they need."

It may well be that the most valuable result of the establishment of more senior fellowships in science on the lines of the scheme recently initiated by the directors of Imperial Chemical Industries, Ltd., will be the contribution it makes to throwing up men of the requisite outlook and calibre for the direction of research. The wise insistence on some combination of teaching with research under conditions where, as Bruce Truscott notes, compared with industry, the fellows can be sure of time and tranquillity of spirit, may stimulate not merely fruitful research itself but also clear and creative thought about the compartmentalism of science, its effect on training or restraint on effective research. From such thought alone can come the competence and confidence to move surely across boundaries and to handle wisely the attack on the unknown, whether it be in industry or elsewhere, with its calls for team-work as well as initiative and individuality.

The Goodenough Report in its brief reference to research well stresses, in quoting from the evidence submitted by Sir Thomas Lewis, the importance of these last factors. Organization, in fact, must be secondary to the selection of personnel. Unless we can secure an adequate supply of men of the right gifts no organization will ensure the prosecution of effective research, and the essential preoccupation of wise administration is, as Alan Gregg observes, to create and foster the circumstances, the human relationships, in which gifted men will be most productive and prodigal of their gifts. In particular, he points to two dangers which our strategy must frankly recognize and provide against: first, the tendency to waste research ability by diverting it into other channels by the demands of administration and teaching; and secondly, the tendency for the endowment of research to deprive the investigator of his primary right of choosing a subject to be studied, of framing a hypothesis to be tested, of planning and performing some crucial experiment.

It may be noted in passing that Mr. Gregg looks to senior fellowships for research of much the same type as those contemplated in the scheme of Lord McGowan and his fellow directors to meet this need, though he appears to have a slightly higher standard of status and emolument immediately in mind. The basic strategy is clearly the same, and the same close resemblance in the conclusions reached by progressive minds in Great Britain and in the United States may be discerned in the broad objectives of some of the programmes of research. The differences in content are frequently rather in points of detail than in scope, though the emphasis on particular aspects of the programme must obviously vary.

A noteworthy example may be found in the field of agriculture. The research programme recently adumbrated by the Parliamentary and Scientific Committee in its report, "A Scientific Policy for Agriculture", has features in common with the more detailed programme outlined by Dr. E. C. Auchter in his address last autumn to the American Association of Land-grant Colleges and Universities (*Science*, 99, 169, 190; 1944). Whereas the former does no more than indicate that an expenditure of at least three million pounds on agricultural research is required, with the completion of British soil and geological surveys, and intensive and large-scale research into the complex part played by organic matter in our soil, it recognizes that nutrition must play an important part in determining the trend of agricultural research, and like Dr. Auchter again, that agricultural research is linked up with and affected by fundamental research in other fields.

This point, of which the Parliamentary and Scientific Committee has already shown itself

aware in its earlier report on coal utilization, is specially well brought out by Dr. Auchter. In addition to nutrition, he points to the value for plant and animal production of a detailed systematic world geography of soils, climatic conditions, varieties of plants and methods of plant and animal production, to the need for research on new immunizing agents, into engineering and electrical and mechanical problems in agriculture and the use of agricultural products, into the utilization of crop residues and to basic research to extend our knowledge of such substances as starch, proteins, lignin, hemicellulose, enzymes, hormones and vitamins. If for a moment we have passed from the consideration of broad objectives to that of detail. it is to demonstrate more conclusively first, the validity of Dr. Conant's criteria of relevance in determining the broad objectives, and secondly, the way in which programmes are interlocked, and work in furtherance of the broad objectives in one field may involve work in quite another field.

Strategical requirements, whether from the point of view of applied or fundamental research, may well thus require us to reconsider the compartmentalism of science and to facilitate both team-work between workers in one or more sciences and the abrogation of the impediments such compartments offer to effective research. Beyond this the broad strategy of research would seem to involve first the provision, on this basis of relevance to social needs, for the organized study of particular and urgent problems, both in the development of natural resources, as of fuel and power supply and agriculture and their effective utilization in the service of the community, and of nutrition and health, including the treatment or control and the prevention of disease. Such organized study must include adequate provision not merely for many lines of industrial research but also for systematic fundamental research, planned at least so as to assist the advance of science on an even front by filling in the gaps left by individual initiative and with special regard to the borderlines of the sciences at once so apt to be neglected and so richly productive when cultivated. Again the conception of relevance must include relevancy to the needs of the Colonial peoples also, and it is worth noting in passing that the first annual report of the Colonial Research Committee contains an admirable discussion of strategy in relation to the organization of Colonial research.

There are yet two further aspects of such broad strategy which should be noted. First, provision for the organized study of particular and urgent problems the social relevance of which is immediately apparent leads us almost imperceptibly, through the consideration of such questions as transport, the utilization of the land, water supply, the planning of town and country and the location of industry, to the study of a whole range of problems in the social sciences the immediate relevance of which may be less apparent. Without adequate attention to social biology and the biological factors in human relations, to population changes and vital statistics, to psychology, and allied subjects, we shall be without the basic knowledge we require for the evolution of a new social order or for the establishment of better human relations either at the industrial or at the international level, as well as without the effective technique for handling and improving such relations. As Roy Glenday points out in a recent book, "The Future of Economic Society", we need to know much more about the principles and rules which will govern the social and economic organization of the groups of human beings of which the new world order will be composed. Even more emphatically, Dr. J. T. MacCurdy in discussing, in "The Structure of Morale", this problem of organization indicates how far we have to go when he says that man can expect to fabricate a social organization that will be adaptable only when he has developed a liaison system comparable in its intricacy with the individual human brain.

The suggestions for research which Dr. MacCurdy has made in this connexion should be considered in framing our broad programme of research, and they bear closely on the second aspect of strategy which remains to be considered. If there were any scientific workers who imagined that research strategy could be considered entirely without reference to politics, they should have been disillusioned by the reception which has been given to the report of the Parliamentary and Scientific Committee on "A Scientific Policy for Agriculture". The suggestion that policy should not be shaped primarily or excessively by sectional interests but should be based on the application of scientific principles has been represented as an attempt to dictate policy by reference to such principles alone.

The attempt to formulate and to apply an adequate strategy of research is clearly liable to like misrepresentation, for such strategy can only be put into operation when it receives the necessary political support. It must be therefore a primary responsibility of scientific workers in endeavouring to think out such a strategy to undertake simultaneously the corresponding and no less essential task of explaining and interpreting that strategy to their fellow citizens. At this point no less than in the application of scientific and industrial research in industry educational work has to be undertaken. That is a task of co-operation as well as education. As Mr. Glenday observes: "Before scientists can claim the right to plan a new world order, they must first plan science itself by organizing its various departments to the point of making possible effective co-operation between them". Such endowments as Lord Kemsley's travelling fellowships, the fellowships in science offered by Imperial Chemical Industries, Ltd., and the trust fund for economic and financial research established by the Bank of England should be taken by scientific workers as a challenge both to fundamental thinking on the strategy of research and to full and resolute co-operation alike in the exposition and interpretation of science and in setting their house in full order. Their training has developed in them the critical and unprejudiced approach to novel problems in their particular fields; they must now apply this faculty in a wider field.

# THE HUMAN FOOT

**Structure and Function as seen in the Foot**
By Prof. Frederic Wood Jones. Pp. iv+329. (London: Baillière, Tindall and Cox, 1944.) 25s.

PROF. WOOD JONES is a distinguished member of a long line of British anatomists who, from the time of John Hunter, have refused to limit their activities to the dissecting room and to circumscribe their work within the confines dictated by the supposed immediate requirements of surgery. The line includes Owen, Turner, Humphry, Flower, Cunningham, Elliot Smith and, fortunately still with us, Sir Arthur Keith, and Profs. Arthur Robinson, T. H. Bryce and J. T. Wilson. All these professed human anatomy but all were also excellent comparative anatomists, neurologists or embryologists, and the influence of their wide interests on the advance of anatomical knowledge is not adequately realized. Prof. Wood Jones, in continuing this great tradition, has made significant contributions to mammalian comparative anatomy and, in his publications, he has shown great skill in presenting the detail of human anatomy against a background of mammalian structure which enables one to separate most reveal-ingly those human characteristics that can be regarded as primitive from those that are specialized.

In the book under review Prof. Wood Jones gives an excellent account of the structure of the human foot. The account is none the worse for being, from time to time, iconoclastic and even provocative. It takes for granted an introductory knowledge of human anatomy and will be more readily followed if the reader has already studied, as he should have done, the author's "Principles of Anatomy as seen in the Hand", for the two books are complementary. Doubtless every anatomist could find points of detail with which he would not agree, but, in general, the descriptions are clear, succinct and, often, illuminating. The figures, which have been drawn by the author himself, are most helpful in clarifying the descriptions and they possess the added merit of a quite engaging charm. Omissions, too, will be noted by every anatomist, in accordance with individual prejudice. Thus, in the reviewer's opinion, some reference to Wheeler Haines' work on sesamoids and secondary centres of ossification would have been useful, and the absence of reference to the architecture of the bones, and more particularly to Weidenreich's study on the structure of the calcaneum, is surprising.

The interest of the author in comparative anatomy and in the problems of human phylogeny is revealed in every chapter; but he is careful to warn most emphatically against too much reliance on tags of morphology for assumptions, by analogy, as to function. The case against the 'gorilloid' theory of the derivation of the human foot is convincingly presented, though it is, perhaps, too much taken for granted that this theory, in its extreme form, is widely held. Most anatomists are of the opinion that the early hominoid stock was not derived from an anthropoid ape of the degree of specialization of the extant great apes, and most also believe that the separation of the hominoid from the anthropoid stock occurred at an earlier geological stage than has sometimes been held. But, equally, most workers on primate phylogeny cannot overlook the innumerable structural resemblances between the great apes and man. These resemblances are all-pervading. They extend, as Heuser's account of the ten-day chimpanzee 'ovum' shows, to the very early stages of development, and it would be unfortunate if Prof. Wood Jones's demonstration of the unlikelihood of a 'gorilloid' stage in the phylogeny of the human foot was taken to indicate a more remote relationship between man and the anthropoid apes than, in fact, a survey of all the relevant facts appears to warrant. Notwithstanding this caveat, however, Prof. Wood Jones has made his primary phylogenetic point most persuasively, though some of the argument used in establishing it ignores the significance of allometric, or heteroauxetic, growth in producing differences of proportions of bones in quite closely related animals. Those gene changes concerned in the causation of, say, achondroplasia can alter limb proportions most strikingly without leading to the opinion that the resulting dwarfs represent a new species.

On the functional side Prof. Wood Jones's analysis is again often illuminating. This holds especially for the descriptions of muscular activity and the accounts of movements at the different joints of the foot. His insistence on the freedom of movement at the talo-calcaneal joint is noteworthy, since, in spite of the ease with which the facts can be established, the text-book accounts of this joint are unsatisfactory. The account of the arches of the feet emphasizes the importance of the ligaments in the maintenance of the longitudinal bow, as he prefers to call it. Absence of the anterior metatarsal arch is accepted, but there is no reference in this chapter to the views of Morton, Bankart, Lake or Bruce and Walmsley. A little more emphasis on the clinical importance of proper foot function might justifiably have been introduced, especially as some of the opinions expressed have implications for that part of orthopædics which deserves better than to be called, as it is coming to be called in the United States, podiatry.

"Structure and Function" appears in the title of Prof. Wood Jones's book, and the descriptions of isolated structures and functions throughout it are excellent. There is, however, for the reviewer, no satisfactory attempt at integration of the two. That structure is adapted to function is taken for granted, and little stress is laid on structure which may conceivably be non-adaptive. Further, having taken the structural adaptation to function for granted, there is no reference to the importance of the sieve of natural selection in the establishment of the adaptation. Prof. Wood Jones is an unblushing supporter of the theory of the transmission of acquired characters, and inherent in his whole approach to the study of structure there is the restricted teleology of the end in view. The reactions of readers to this approach will doubtless be conditioned by their individual philosophical attitudes. At least one of them, who has, he believes, followed the arguments sympathetically, remains unconvinced by Prof. Wood Jones's examples, and will adhere to the orthodoxy that there is no good evidence for accepting the doctrine of the transmission to offspring of modifications produced in response to functional requirements. Prof. Wood Jones writes: "Every simile that is called upon to explain the ordering and working of structures and organs in the living body is derived from the unliving world of mechanistic physical science. No real understanding of the longitudinal arch of the foot will ever be come by in attempting to assess its character in terms of the triumphs of the architect or the engineer". Ends, not antecedents, satisfy him as they have satisfied many others; most biologists,

however, will prefer Boyle's "industrious indagation of efficients" and will find their apologia in the first chapter of Sir D'Arcy Thompson's "Growth and Form". J. D. Boyd.

# RECENT WORK ON MAGNETOCHEMISTRY

Magnetochemistry

By Prof. Pierce W. Selwood. Pp. ix+287. (New York: Interscience Publishers, Inc.; London: Imperia Book Co., 1943.) 5 dollars.

IN hybrid terms for investigations involving the experimental examination or the theoretical consideration of particular physical properties of substances, the words 'chemical' or 'chemistry' are often used where they serve no useful delimiting or other purpose. The author of this book possibly feels the difficulty, and gives an explicit definition of magnetochemistry as "the application of magnetic susceptibilities and of closely related quantities to the solution of chemical problems": This, however, is not a severe limitation, for any problem of structure, whether atomic, molecular, or crystalline, which arises in the consideration of the experimental results, may be regarded as a chemical problem; and in fact the subject-matter of the book is virtually the entire range of results for susceptibilities, and their interpretation.

The author makes graceful acknowledgment to other books on the general field, and does not give detailed references to work prior to 1934. Since then to the end of 1942 he states that more than one thousand papers on magnetochemistry have appeared. The problem of selection seems to have been avoided by referring to all of them, for specific reference is made in the text to some twelve hundred papers indicated in footnotes. The book is thus in the main an extensive survey of the recent literature along lines similar to those followed in the "Annual Reports" of the Chemical Society. It would, therefore, scarcely meet the needs of those seeking an introductory or a general account of magnetochemistry; but to those who already have some familiarity with, and interest in, the subject such a survey can be of immense service, particularly at the present time.

The author's own practical experience is evident in the first chapter, where the most useful methods for determining susceptibilities are briefly but clearly described. Among the general explanatory remarks, however, there are a number of loose or definitely incorrect statements. It is stated, for example, that substances are called dia- or para-magnetic according to whether the "intensity of the field" in the substances is smaller or greater than that in the surrounding space (p. 1); that for ferromagnetics the intensity of magnetization becomes proportional to the field "only at high fields, when the specimen is said to be saturated" (p. 17); that specific magnetization is "given by the slope of the susceptibility plotted against reciprocal field strength" (p. 18). Slips of this kind are fortunately not typical of the whole book.

The main subject-matter is grouped in seven chapters each covering a particular class of substance. The grouping is not explicitly discussed, but from a magnetochemical point of view it is logical and convenient. The chapters deal with atomic and molecular diamagnetism, atomic and molecular paramagnetism, complex compounds, metallic dia- and para-magnetism, and ferromagnetism. A final chapter deals with miscellaneous topics under the general heading of applied magnetometric analysis.

Atomic magnetism is, as usual, taken as a general term covering the magnetism of ionic crystals, in connexion with which experimental work and the quantitative theoretical treatment earliest reached a fairly advanced stage. The survey is mainly of additional data accumulated during the last ten years. The author deliberately refrains from including tables of susceptibilities, on the ground that "Annual Tables" of such data are to be published; but it may be suggested that much of the information included in the continuous narrative could have been conveyed in more convenient form by means of suitably annotated tables. It is surprising to find how incomplete the experimental information still is on the compounds of transition elements other than those of the first and of the rare earth series.

The most valuable parts of the book are the chapters dealing with molecular paramagnetism and complex compounds, on which the experimental work in recent years has been very extensive. It may happen that the susceptibility is determined, with close approximation, by the number of unpaired electron spins in the molecules, the magnetic effect of any orbital moments being negligible; when this is so, and if no searching inquiry is attempted, the magnetic aspect of the problems is often fairly simple. Not so the chemical aspect; for very difficult problems of structure may arise in connexion with, for example, organic free radicals and biradicals, complexes such as those of chromium and manganese, and hæmoglobin and related compounds. Magnetic measurements are proving invaluable as a guide, and it is most useful to have a survey written with so thorough an appreciation of the chemical background.

To many physicists the magnetic properties of metals are now of outstanding interest, partly, perhaps, just because they are beyond the scope of the theory which is adequate for 'normal' dia- and paramagnetics. It is useful to have recent results collected together, but the theory of metallic magnetism is barely mentioned, and without it the significance of the susceptibility data is not brought out. Much the same remark applies to the material surveyed in the chapter on ferromagnetism, though here there is considerable specific value in the systematic survey of the results for the oxides and other ferromagnetic compounds of iron, and of the non-ferrous ferromagnetic compounds, which are often dismissed rather summarily.

The last chapter includes a description of a number of instruments used in metallurgical control, and a rather sketchy survey of magnetic work on the structure of alloys; it closes with some statements about the susceptibility of sea urchin eggs and sperm.

Those who write surveys of scientific literature undertake a thankless task. Omission of reference to some particular piece of work may give offence; completeness of reference, in reasonable space, is possible only at the sacrifice of other desirable qualities in a book. Over most of the field the references here seem all-inclusive, and as a comprehensive digest of the literature the book is beyond reproach. It might have been much more readable if the author had been less conscientious, and had not attempted to cover so wide a range. The book, however, will probably be used mainly for reference,

so that the paragraph which states merely that colloidal magnetite has been examined, and the remarks on sea urchin eggs, may fulfil a useful purpose. The author expresses the hope that the book may contribute, however infinitesimally, to the labours of those scientific men who are seeking to parry the blows of an enemy. It may not do that; but it certainly will perform a valuable service in one small region of endeavour in helping to bridge the devastating gap which is being made by the war years.

E. C. STONER.

## SURVEYING FOR STUDENTS

### Higher Surveying

By Dr. Arthur Lovat Higgins. Pp. viii+463. (London: Macmillan and Co., Ltd., 1944.) 25*s.* net.

THAT Dr. A. L. Higgins is an enthusiast where the subject of surveying is concerned will be evident to readers of his latest book entitled "Higher Surveying". It is written on somewhat unorthodox lines, each section consisting of a number of "Articles" followed by a selection of examples.

Though ostensibly written for students, the book should have a much wider appeal. The articles are well written, and many of them are concise critical essays on appropriate surveying topics: they include many historical references and discuss modern developments. It may be that these scholarly outlines will sometimes be more appreciated by those who already have a good knowledge of surveying than by the student whose horizon is less wide. Even if not fully understood by the student, however, they will give him a broad view of the subject, into which later knowledge can be fitted.

The impression is given that Dr. Higgins had a great deal of trouble in deciding the scope of the book, and in fixing its title. In the first place, he had so much material that he decided to jettison much that was of a more elementary character, and also some details of field technique which the student might be expected to learn in the field. It probably seemed too drastic to carry out this policy rigidly, and opportunities have been taken in the text and examples to incorporate much that is not strictly 'higher surveying', but which completes and rounds off the treatment of other subject matter. Even with these omissions the author's troubles were not ended. He was anxious to include a considerable number of worked examples taken from university examination papers, and also others for the student to solve. Consequently, with the space at his disposal, he had either to omit subject matter he was anxious to include, or deal with it in a less detailed manner than he would have wished. In some cases the examples have been used, not to illustrate the text, but to supplement or even as a substitute for it. In other cases the text is somewhat too concise and condensed for easy reading. The reviewer considers that Dr. Higgins has overcome his difficulties very successfully, and the book cannot fail to be of great value to its readers.

The six main sections of the book deal respectively with (1) instruments, (2) engineering surveys, (3) photogrammetry, (4) field astronomy, (5) geodetical surveys and (6) errors in surveying.

These sub-titles sufficiently define the scope of the book. It is from the section on engineering surveys that much of the elementary work on chain surveying, traversing, levelling, plane-tabling, etc., has been omitted. Section 3 deals with both ground and aerial surveying, and is necessarily selective. The last section, of about sixty pages, dealing with errors of surveying, contains a mass of information, the theoretical work being rather too concisely expressed, but with the applications fully explained by means of numerical examples.

Finally, it may be said that the production is excellent, and the publishers are to be congratulated on presenting so well, in war-time, this most useful and attractive text-book.

W. N. THOMAS.

## THE STUDY OF FINE PARTICLES

### Determination of Particle Size in Sub-Sieve Range

A Report of Discussions. Pp. 69. (London: British Colliery Owners' Research Association and the British Coal Utilisation Research Association, 1944.)

THE measurement of fine particles is a subject of increasing importance in many industrial processes and in the study of natural phenomena concerning soils and dusts. It is now realized that the influence of very fine particles is so predominant that in many researches measurements would be desirable to a lower limit of one micron in diameter, though it is not often that this degree of accuracy can be attained. The above report contains an account of the activities of two research associations having the object of improving particle size measurements, and they may be complimented on the broad way in which the problem has been treated.

The volume reports two informal conferences held to discuss the subject, with an introductory paper by Drs. Skinner and Boas-Traube and Messrs. Brown and Hawksley. This paper summarizes recent developments in the measurement of fine particles, dealing with microscopical measurement, the dispersion of various powders in liquids, and in considerable detail with the measurement of size distribution by determining the rate of change in optical density of a dilute suspension of the powder in a liquid. This latter method is now being extensively used both for research purposes and for the rapid checking of industrial products as a routine procedure. The report of the second conference expresses the views of research workers from various laboratories of the Department of Scientific and Industrial Research and a wide range of industrial organizations.

From this discussion it is apparent that the problem needing most urgent research is that of effectively dispersing a powder in a liquid, since this procedure is involved in almost all methods of sub-sieve particle-size determination. A large number of peptizing agents have been suggested for various powdered substances, but no general theory has yet been developed that would obviate the present method of proceeding by trial and error. Many processes and designs of apparatus are now available for measuring sub-sieve particles which are satisfactory for comparing the fineness of various powders, but serious discrepancies are shown to exist when the same powder is tested in different designs of apparatus. Thus it is evident that further research is necessary on many details before the absolute size distribution of the finest particles can be determined; but the report is a valuable guide to those engaged on particle-size measurement regarding the choice and most effective way of using such apparatus as is available.

H. HEYWOOD.

## Solvents

By Dr. Thos. H. Durrans. (Monographs on Applied Chemistry, Vol. 4.) Fifth edition, revised and enlarged. Pp. xii+202. (London: Chapman and Hall, Ltd., 1944.) 17*s*. 6*d*. net.

WHEN this book was first published in 1930 it was not generally appreciated how useful organic solvents were and how wide their application could be. Since then they have become of prime importance, and their manufacture is an important section of the fine chemical industry. This little book has undoubtedly contributed to their use; it gives just the required amount of information in detail about each of them, as well as a general section about their behaviour in general. Organic solvents have adverse as well as useful properties: they are toxic and have a considerable fire risk. Workers with them risk chronic poisoning, so that guidance in their use is required: the book contains the necessary information including the relevant data regarding critical concentrations. Similar data are given for the explosive limits of the various substances.

There are now so many of these solvents, most of them sold under trade names, that it is hard to know what they are. The appendix giving the trade names and probable composition is therefore especially valuable: it occupies eight pages with some four hundred entries.

A second appendix shows in tabular form the power of the solvents to dissolve twenty-five named substances mostly used by the plastics industry. The work is a mine of information, and its frequent revision enables it to be kept up to date and accurate.

There is no indication of any particular new solvents, though such are continually being added to the list. Dr. Durrans is to be congratulated on his efforts, which are greatly appreciated by all users of solvents.

## Aeroplane Flight

By H. F. Browne. Pp. 167. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1944.) 7*s*. 6*d*. net.

THERE is already a flood of books on the elements of aerodynamics purporting to be written in non-technical language for the beginner. Many of these fail to fulfil their authors' intentions simply because the explanations assume a knowledge of mechanics and physics not to be expected of the non-technical reader. Mr. Browne does not commit this mistake. He explains the principles of mechanics as he meets them in very simple language, using homely everyday examples, illustrated by unique sketches of his own preparation. These diagrams are perhaps the most outstanding feature of the book, and they have been made to illustrate the text in a way that photographs or sketches of actual aircraft parts could never equal.

The subject is discussed in chapters each dealing with some part of the theory of flight such as lift, stalling, drag, thrust, control, stability and performance. There is also a discussion on the mathematical units involved, leading up to a chapter on wind tunnels and the interpretation of their results. The explanations of some of the more complex ideas are extremely good. The mechanics of the airscrew, the gyroscope and gyroscopic action, and the meaning of "Reynolds Number" in aerodynamic experimental work, are examples of the way in which the author has succeeded in putting the technical facts into language that is both simple and mathematically true.

While this book is essentially for beginners, its method of presentation of the subject might well be studied by many teachers.

## The Annual Register

A Review of Public Events at Home and Abroad for the Year 1943. (New Series.) Edited by Dr. M. Epstein. Pp. xii+176. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1944.) 42*s*. net.

THE new issue of this annual record follows the usual arrangement. The greater part is devoted to a factual and objective story of world history divided into national sections, half of which treat of Great Britain and the Dominions; the British Colonies have no separate section. The record is chronological, which puts the social history into perspective with the history of the War, and so gives an admirable sketch of human interests in the year. Under the headings of various enemy or enemy-occupied countries, there is much social history, some of which failed to receive adequate notice in the restricted newspapers of to-day.

The second half of the book has the usual surveys of literature, with reviews of some outstanding books, art, music, drama, science, law and finance. The review of scientific achievements is comprehensive though very condensed and perhaps less readable than some of the other sections. Then follows a record of events, obituary notices and a long and detailed index.

In addition, certain public documents printed in full include the Anglo-Chinese Treaty concerning Extra-Territorial Rights. In spite of the crowded events of the year, the editor has succeeded in producing a balanced volume of the same size as previous issues.

## Elements of Radio

By Abraham Marcus and William Marcus. Prepared under the editorship of Ralph E. Horton. Complete edition. Pp. xiii+699. (London: George Allen and Unwin, Ltd., 1943.) 27*s*. 6*d*. net.

THIS book, printed in the United States, is in the nature of an elementary course of instruction in radio technique on very practical lines. The authors state that as a result of many years experience of teaching this subject, they consider it a mistake to require the student to learn a mass of laws and principles of electricity before teaching him radio. The first half of the book deals with the radio receiver, starting with the crystal detector and leading up through valve detectors and amplifiers to the superheterodyne type of receiver. The second half of the book is slightly more advanced, and deals first with the phenomena of direct and alternating current electricity and their applications; and then with the essential characteristics of radio transmitters and auxiliary equipment.

The style throughout is very elementary, with very clear diagrams, and includes a series of questions, problems and practical exercises and demonstrations, all of which are probably very suited to a particular type of instruction designed for a short-period (one year or less) course. Only the simplest of formulæ are included, such as for the calculation of circuit constants; and the technical material is clearly and accurately presented.

# MEANING AND SCOPE OF SOCIAL ANTHROPOLOGY

By PROF. A. R. RADCLIFFE-BROWN
University of Oxford

THE name 'social anthropology' came into use some sixty years ago to distinguish the subject from ethnology. The avowed aim has always been to apply the inductive method of the natural sciences to the study of human society, its institutions and its evolution. But it is only gradually that we can learn how to apply the inductive method in a new field. The history of chemistry from the time of Bacon to Lavoisier illustrates this. So social anthropology is not now what it was in 1890. At that time theoretical discussions in social anthropology were largely concerned with speculations about origins (of religion, of totemism, of exogamy, etc.). There are still some social anthropologists who remain faithful to the ideas and methods of 1890. But the work now being done in the subject consists largely of experimental studies, combining observation and analysis, of particular social systems, intended to provide material for the systematic comparison of systems of different types and to test existing hypothetical conceptions. Anyone who wants to know what social anthropology is doing at the present day should read the admirable work of Arensberg and Kimball on "Family and Community in Ireland".

One of the most completely organized departments of anthropology is that of the University of Chicago. The subject is divided into five fields: physical anthropology, archæology, ethnology, linguistics and social anthropology. Students, who must already have the degree of B.A. before entering the department, are required to devote a period of study to all five subjects and pass a comprehensive examination in all of them. Thereafter the student specializes in one of the fields for his degree of Ph.D. A brilliant student can complete this work in four years, but many take longer.

We may consider this combination of subjects from the point of view of each one of them in turn. Physical anthropology proper, as distinct from human biology, is the study of variation in the human family (the Hominidæ) and of human evolution. It includes, therefore, not only the study of existing varieties of *Homo sapiens*, but also human and primate palæontology. A student who aims at being a competent physical anthropologist must first obtain a thorough grounding in biology, comparative morphology (particularly of the primates), human anatomy, histology, embryology and physiology. It seems desirable that he should have some acquaintance with archæology and ethnology. His own special work will in no way be helped by any study of linguistics or social anthropology.

Ethnology, as the name shows, is the study of 'peoples'. Peoples, or ethnic groups, differ from and resemble one another in racial character, in language and in culture. The ethnologist compares and classifies peoples on the bases of these similarities and differences, so that he has to deal with racial, linguistic and cultural classifications. Further, he seeks to discover by various methods something about migrations, interactions and developments of peoples in the past.

It is evident that the competent ethnologist should possess a sound knowledge of physical anthropology, linguistics and social anthropology. Ethnological literature is very heavily overloaded with uncritical speculations. A writer who talks glibly of brachycephaly and dolichocephaly but is completely ignorant of the complexities of structure of the skull will offer us an account of the movements and developments of races from the first appearance of man. One who is ignorant of linguistic science will affirm a connexion of two widely separated languages on the evidence of similarities of a few words selected from imperfect vocabularies. Or one who, by his lack of knowledge of social anthropology, is ignorant of the nature of institutions such as totemism or exogamous moieties, will affirm that these institutions all over the world must have been introduced by Egyptians looking for gold, pearls and cowrie shells.

Prehistoric archæology is really one kind of ethnology (palæo-ethnology), the study of the peoples of the prehistoric past who are known to us only from their remains—their dwelling sites, their bones, the implements they made and used. Since the archæologist recovers no traces of the languages or the social institutions of these vanished peoples he has no need, in the pursuance of his own special studies, for any knowledge of linguistics or social anthropology. On the other hand, he has to know something of geology and surveying. It would seem to be most desirable that ethnology and archæology should keep closely together. They are merely branches of a single study.

Linguistics, the systematic study of language in general, as distinguished from the study of particular languages or groups of languages, is regarded in the United States as one of the fields of anthropology. In England the subject, as a subject, has not yet received recognition except in the School of Oriental Studies, London. A student who intends to specialize in linguistics does not really need to know anything more about physical anthropology or prehistoric archæology than ought to be known by every educated person. But there are important connexions of linguistics with ethnology and social anthropology. For example, the ethnological problem of the Aryan people is a linguistic problem as well as an archæological, racial and cultural problem.

We come finally to social anthropology—the general theoretical study of social institutions—law, religion, political and economic organization, etc. Within his own field of study, the social anthropologist has no use for physical anthropology. If it should ever be proved that racial (that is, biologically inherited) characters influence social institutions or their development, then he would take due note of the fact.

Prehistoric archæology obviously makes no contribution to such branches of social anthropology as comparative religion, the comparative study of law or of kinship or of economic systems. It does not even provide very much help to the study of comparative technology as that is conducted in social anthropology, where what is sought is to determine the mutual interrelations between the system of techniques and the other parts of the total social system. Certainly a social anthropologist should be acquainted with the general results of prehistoric archæology, but the methods of the archæologist and the details of investigation are not his concern as a social anthropologist.

There is often a good deal of confusion about the relation of social anthropology to ethnology. To a certain extent, but only to a certain extent, they deal

with the same facts. But they deal with them in quite different ways. A typical problem of ethnology is how and when the ancestors of the American Indians entered the continent of America and how they developed the differences of racial character, language and culture which they exhibited when Europeans first came in contact with them. A typical problem of social anthropology is, "What is the nature of Law ?" An ethnologist and a social anthropologist might both study the same American Indian tribe, but one would be looking for facts relevant to his aim of placing the tribe within his general picture of the peoples of the continent; the other would be examining the way in which the tribe deals with infractions of custom in its bearing on a general theory of the nature and function of law.

Since both ethnology and social anthropology need field studies, there is an obvious economy of labour if a field worker can provide the material needed by the ethnologist and also that needed by the social anthropologist. In some field studies this has been done. But a field study in social anthropology needs more than description; it requires theoretical analysis. There are innumerable examples of ethnographic monographs which are admirable for the purposes of ethnology but are extremely unsatisfactory to the social anthropologist who might wish to make use of the data.

Ethnographical field studies are generally confined to the pre-literate peoples. In the last ten years, field studies by social anthropologists have been carried out on a town in Massachusetts, a town in Mississippi, a French Canadian community, County Clare in Ireland, villages in Japan and China. Such studies of communities in 'civilized' countries, carried out by trained investigators, will play an increasingly large part in the social anthropology of the future.

It is now possible to see that what holds the various branches of anthropology together is the central position of ethnology (with archæology) as the geographical, historical and classificatory study of races and peoples, past and present. It is for this reason that ethnology and anthropology are sometimes regarded as being one and the same. It is an interesting fact that the symposium (as it is now commonly called) on the future of anthropology at the centenary meeting of the Royal Anthropological Institute included discussions on physical anthropology, archæology, social anthropology and the study of material culture. There was no one to speak on the future of ethnology. Ethnology takes contributions from physical anthropology and linguistics, but gives little to them in return. Social anthropology as the study of evolution is in bad odour with some ethnologists at present, so that while they give little they also take little.

But what of the relations of the branches of anthropology to subjects that lie outside the field of anthropology ? Physical anthropology has its closest connexion with the biological sciences. There is a tendency to seek to absorb it into a wider study of human biology, which would, presumably, also include what is called social biology. The study of the Bantu languages or the languages of the American Indians is left to the anthropologist, but not the study of the Indo-European and Semitic languages. How (and why) draw a line between prehistoric archæology and the archæology of historic times ? But if no such line is drawn, archæology becomes continuous with history. Ethnology, or some part of it, is claimed as a subdivision of geography—ethnogeography. And where, at the present time, are we to put anthropogeography or human geography, in geography or in anthropology or in both ?

Ethnology deals with the history of peoples. But the rest of history is excluded from anthropology. Yet the closest connexion of social anthropology is with the history of institutions—economic history, the history of religion, of law, of political organization, of science, etc. But to the social anthropologist the history of Europe or of Christianity is of no more interest than the history of India or China, of Islam or Buddhism.

The writer of the article on "The Future of Anthropology" (see *Nature*, Nov. 20, 1943, p. 587), which surveyed the discussion at the centenary meeting of the Royal Anthropological Institute, asks, 'Who is to study the world-wide history and development of social institutions ?" The answer is, in the first place, the historians. The social anthropologist cannot examine for himself the original sources for the economic, political, legal and religious history of ancient Greece and Rome, India, China, Russia, Persia and Turkey. It is unusual for him to be thoroughly competent in even one of these fields. The social anthropologist, for the most part, has to take the facts about institutional history and development from the historians, though, of course, he has to exercise his judgment as to the reliability of a particular historian. What the social anthropologist does with this material is to use it to formulate his general hypotheses about law, religion, economic organization and so on. But these hypotheses need to be verified; and although some verification is possible by the comparison of different historical societies, the final test lies in actual (experimental) observation of existing social systems.

Political systems, economic systems, and systems of law are studied in social anthropology and also in economics, political science and jurisprudence. But there are very important differences of method. One of these, though by no means the most important, is that in the three studies mentioned attention is usually confined to certain types of society, whereas social anthropology has for its field all human societies and therefore tends to pay most attention to those which are neglected by the social sciences. It is true that at present there is no close connexion of the three social sciences with social anthropology, but this may be expected to develop as the last-named subject itself develops.

As anthropology is at present recognized, psychology lies outside. Yet social anthropology stands in a very close relation to psychology. To make the relationship clear it is necessary to distinguish between two kinds of psychology. Psychology is here taken to mean the study of the mental or psychic systems—if you will, the behaviour systems—of organisms. We may study the behaviour, the external manifestations of the psyche, of earthworms, rats or chimpanzees. General human psychology deals with the mental characteristics which are possessed by all human beings. Social anthropology deals with the characteristics of all human social systems. A social system consists of a certain set of social relations between certain human beings, exhibited to observation in their interactions with one another. It is obvious that one determining factor in the formation of human social systems is that basic human nature which it is the business of the general psychologist to study. Similarly, the nature of multicellular organisms is determined by the nature

of the living cell which it is the business of the cytologist, the biochemist and the biophysicist to study. The connexion between social anthropology and general psychology is just as close and of just the same kind as the relation between animal physiology and cytology.

There are also what may conveniently be called 'special psychologies'. These deal, not with the universal characteristics of human beings, with basic human nature, but with the special mental or behaviour characteristics of individuals, types, classes or groups. Psychiatry affords an example of a 'special psychology', as do attempts to define psychological 'types'—extrovert, introvert; schizophrenic, cyclothymic; pycnic, asthenic.

One of the 'special psychologies' consists of the study of the psychical characteristics (that is, characteristics of mind or behaviour) of the members of a defined social group, either a local community or a defined social class within a local community. When we study the 'psychology' of the French or the Germans or the people of the United States, we are dealing with those characteristics of mind or behaviour that result from 'conditioning' by a particular social system. Here the 'special' characteristics with which we are concerned are determined by the social system, while the social system itself is determined by the general characteristics of basic human nature.

It should be evident that there is a two-way connexion between social anthropology and psychology. Human societies are what they are because human beings are what they are. Similarly a human body is what it is because living cells are what they are. But why human beings belonging to a particular society or group exhibit certain characteristic modes of behaviour is because they have been 'conditioned', as the phrase is, by that society. Similarly the cells of a muscle act and react as they do because they are individual members of the muscle.

Prof. F. C. Bartlett (*Nature*, Dec. 18, 1943, p. 700) proposes drastic changes. He would give no place in anthropology to archæology, to linguistics (the general study of language), to ethnology (the geographical and historical study of races and peoples), or to social anthropology (as the comparative study of the forms of association found among human beings or as the study of social evolution). He would retain physical anthropology or anthropometry if it would abandon its present aim of studying evolution, variation and heredity in the human family and would devote itself to measuring physical characters that are correlated with differences of behaviour. He would also admit the study of material culture so long as it was limited to the study of the applications of natural knowledge and their influence on behaviour. He adds two other disciplines. One is the study of the effects of general environmental conditions on behaviour. The other is the study of "a group's psychological possessions, its traditions, beliefs, customs, ideals and of their repercussion upon social conduct". For Prof. Bartlett, anthropology should become a group of special psychologies dealing with the effects on behaviour of anatomical characters, environment, knowledge and the 'psychological possessions' of groups. Anthropologists need not fear, however, that Prof. Bartlett's drastic reforms will be carried out in the near future. Meanwhile, that 'special psychology' which is concerned with the way in which the behaviour of individuals is determined by the 'culture' of the society in which they live is already part of social anthropology. But to say that it should be the whole of it is to deny to social anthropology the right to that study of the nature of social systems and of their evolution which is the *raison d'être* of the science.

Applied social anthropology is not much more than twenty years old. It was developed in South Africa, England and Australia in connexion with problems of Colonial administration. About twelve years ago it secured, despite the opposition of some ethnologists, a footing in the United States, not only in the Indian Bureau but also in the Soil Conservation Bureau and in an investigation of factory efficiency carried out in a large factory under the direction of Prof. Elton Mayo of Harvard. Since the United States came into the War, large numbers of anthropologists have been called to Washington to carry out work which either is, or is supposed to be, applied anthropology.

There is a good deal of misunderstanding about applied anthropology, what it is, what it can do and what it cannot do, but that matter obviously cannot be discussed here. The recognition of applied social anthropology has certain very definite advantages and certain equally definite disadvantages. To mention only one of the latter, theoretical social anthropology is still in the formative stage. The demand on social anthropologists to spend too much of their time on practical problems would inevitably reduce the amount of work that can be given to the development of the theoretical side of the science. But without a sound basis in theory, applied anthropology must deteriorate and become not applied science but merely empirical practice.

What of the future? Social anthropology must claim a position of relative independence. (There are already chairs of social anthropology at Oxford and Cambridge.) This does not mean that it should sever its connexion with ethnology, with which it has always been associated; and its connexion with ethnology connects it indirectly with prehistoric archæology. It should maintain a close connexion with general linguistics, for language is a social institution. (At Oxford the only lectures on general linguistics have been those given in the Institute of Social Anthropology.) It could maintain a closer connexion with human biology than with the narrower subject of physical anthropology.

Outside the field of what is called anthropology, it must maintain or establish connexions with psychology, with history (more particularly economic history, the history of law, of political organization, of religion) and with economics, political science and jurisprudence. The history of culture, in the sense of the history of art, of music, of literature, ought not to be neglected in any complete social anthropology, nor, of course, technological history. In the training of a social anthropologist the first essential is a real understanding of the experimental method in scientific investigation, and this is best acquired by a thorough study of the history of science.

One part of social anthropology is the comparative study of economic systems. Surely there ought to be close connexion between this study and economics and economic history. Another part of social anthropology is the comparative study of legal systems, which demands a similar connexion with jurisprudence and the history of law; and so on with other parts of social anthropology. But what part of social anthropology would give a similar close connexion with the study of the somatic differences exhibited by the various races of mankind, or with the study of the date and the affinities of the Solutrean

or Capsian culture ? So long as ethnology continues to exist, it will provide a meeting-ground for archæologists, physical anthropologists, students of linguistics, and social anthropologists. Such a meeting-ground has been provided for a century by the Royal Anthropological Institute and will continue to be provided in the future. Any attempt to impose a more rigid artificial unity will be likely to produce exactly the opposite of the result at which it aims.

# GENETICS AND KARYOLOGY OF *DROSOPHILA SUBOBSCURA*

By Dr. U. PHILIP, J. M. RENDEL, H. SPURWAY and Prof. J. B. S. HALDANE, F.R.S.

MODERN genetical theory is largely based on the study of *Drosophila melanogaster*, which has proved a useful guide to the genetics of other organisms. But there has been a tendency to regard this species as a standard, and any deviations from its genetical behaviour as exceptions.

The genetical study of other species of Drosophila has not merely opened a promising field of comparative genetics; it has also demonstrated that most species show qualitatively novel features. Thus *D. virilis* has a number of labile genes, *D. miranda* has two *X*-chromosomes. In *D. ananassæ* the males are triploid for at least one gene. *D. pseudo-obscura* A, though apparently monotypic, is polymorphic for a number of intra-chromosomal gene orders, each with its characteristic geographical range; and *D. subobscura* has been found to be a structural heterozygote in both sexes. In general the comparison of species suggests that they differ at least as much in the arrangement and proportions of the gene material as with regard to genes themselves.

C. Gordon[1] began the genetical study of *Drosophila subobscura*, and we owe some of our stocks to him. The study was continued by Gordon, Spurway, and Street[2] and Christie[3], and we hope shortly to publish a series of papers on it. The species belongs to the *obscura* group of the subgenus Sophophora (Sturtevant[4]), and its diagnostic characters are given by Gordon (1936) according to Collin (unpublished). It appears to be a native British species, and seems to have a wide distribution in Europe. For in a letter sent just before the outbreak of war with Italy, Buzzati-Traverso and Pomini, of the University of Pavia, informed us that flies of our stocks had given hybrids with flies of a species found in Italy and Germany, on which they had made genetical and cytological studies. Its possible identity with Sokolov and Dubinin's[5] *D. obscura*-3 from the U.S.S.R., is discussed later. The flies can be caught fairly regularly under 'bleeding' elms and oaks. We know little of the several related British species, and have so far not attempted to study their systematics.

At mitotic metaphase there are five pairs of telomitic rod-shaped chromosomes, and one pair of 'dots'. The *X*- and *Y*-chromosomes, which are of equal length, are the longest pair of rods. They can also be distinguished from autosomes in that somatic pairing only occurs at their proximal ends.

The salivary gland nuclei contain one short and five long elements. The *Y*-chromosome is exceptional in including at least 15 euchromatic bands, which have homologues in the *X*. One of the autosomes carries a large swelling similar to the 'Balbiani Ring' of Chironomus. The long chromosomes contain a good deal of heterochromatin. In all other Drosophila species so far described, except *D. busckii*, the heterochromatin of the proximal ends of the chromosomes forms a large darkly staining chromocentre. In *D. subobscura* this heterochromatin consists of large pale granules, and there is no chromocentre (Emmens[6]).

The most interesting feature of the species is the polymorphism of the chromosomes, each of which presumably represents one element in Muller's[7] terminology. Almost all larvæ both from wild parents and laboratory cultures show inversion configurations in one to five of the long chromosomes; no translocations have been found. The different chromosomal orders fall into two groups.

(*a*) Both homozygous forms seem as viable and fertile as the heterozygote. In the four cases of this type so far studied, one order is by far the commoner, and may be taken as the standard, from which the other orders may be said to differ by one or more inversions.

(*b*) In three cases the heterozygote appears to be more viable and fertile than either homozygote. Most larvæ show salivary configurations proving that in at least two of the paired autosomes the homologues differ in respect of a compound inversion. These inversions are an included inversion covering the middle third of one autosome, two adjacent inversions covering three fifths of another, and a pair of overlapping inversions covering the distal quarter of a third autosome. Thus three of the autosomes have two (if not more) equally common isomeric orders. As they differ in respect of compound inversions, these should reduce crossing-over in heterozygotes very efficiently.

From a cross between two structural heterozygotes, or between a heterozygote and a homozygote, we should expect equal numbers of larvæ homozygous and heterozygous for a particular chromosome. In fact, there are significantly fewer homozygotes, though the nature of the selection against them is so far unknown. Its efficiency may be judged from the fact that a line which, before inbreeding, was heterozygous for the three inversions the heterozygosity of which is favoured by selection, is still heterozygous for all of them after fifteen generations of brother–sister mating. This would only be expected in one of 37,000 such lines in the absence of selection. Another similar stock was still heterozygous for all three after ten generations of brother–sister mating; after nineteen generations it was still heterozygous for one, and died out during the twenty-first. Stocks made cytologically homozygous for any two of the three orders tend to die out; however, we have one cytologically homozygous stock derived from a fertilized wild female; but this is extremely difficult to keep alive, though it can easily be crossed with our other stocks.

Thus the species resembles a permanent structural heterozygote such as many Oenothera species, though structural homozygotes are not quite inviable. Sokolov and Dubinin (loc. cit.) reported a similar structural heterozygosity in a species from Ukraine and Caucasia which they referred to as *Drosophila obscura*-3 without giving diagnostic characters. The detailed structure of the inversions seems to be different, and it will be of great interest to determine how close systematically their populations are to ours.

In some vertebrate species, such as mice, pure lines can easily be established. In others, brother–

sister mating leads to low viability or infertility, or else to lines which are not as homogeneous as expected. It is at least possible that in such cases cytological investigations may reveal a condition like that of *D. subobscura*. In any event, a small and rapidly breeding animal species in which inbreeding is harmful is a valuable object of genetical study.

In our present stocks forty-seven loci are marked by visible mutants, several of them by a series of allelomorphs, and forty-four of these loci have been assigned to linkage groups. On the $X$-chromosome we have fourteen loci, apart from lethals. Some of the sex-linked mutants, such as *yellow, cut, singed* and *bobbed* with a terminal locus and a normal allelomorph in the $Y$, are clearly homologous with those of other species. The homologies of the autosomal mutants are more doubtful. The most striking mutants without obvious homologues in other species are an incompletely recessive *white testis*, with no change in eye colour; *bulge*, a sex-linked recessive hypertrophy of the eyes, which may be folded without disarrangement of the facets; *short costal* vein, a sex-linked recessive abolishing one of the diagnostic characters of the genus; and *six-jointed*, an autosomal recessive giving an extra tarsal segment and rough eyes.

Many of the mutants were obtained by inbreeding the progeny of wild flies. Most of these are autosomal, but three are sex-linked. One of these, *withered* wing, found by Street and Gordon (unpublished), is interesting as being sex-limited, only appearing in homozygous females, and not in hemizygous males. It is therefore, like an autosomal recessive, largely shielded from natural selection. Though located near the proximal end of the $X$, it has no normal allelomorph in the $Y$-chromosome like *bobbed*. The other two, a lethal and a visible *dried wing*, are ordinary sex-linked recessives.

Since each long autosome will ultimately have three maps, one for each homozygous chromosome order, and one for the heterozygote, mapping is a slow process, but it is certain that the maps of all five long chromosomes will be longer than those of *D. melanogaster*. That of the $X$ is more than 150 units long, compared with 67 in *D. melanogaster*. The minimal estimates of the length of the long autosomes vary from 80 to 140 units, as compared with 47 to 55 units for the arms in *D. melanogaster*.

The total lengths of the genetical maps of different species of Drosophila are:

| | |
|---|---|
| *Drosophila virilis* | 788 (Chino)[8] |
| ,, *subobscura* | 570+ |
| ,, *pseudoobscura* A | 420 (Sturtevant and Tan)[9] |
| ,, *ananassæ* | 326 (Kikkawa)[10] |
| ,, *simulans* | 311 (Sturtevant)[11] |
| ,, *melanogaster* | 280 (Brehme)[12] |

Thus *melanogaster* is far from typical of the genus. Since the species do not differ markedly in the numbers of bands in the salivary chromosomes, the differences in map-length are probably due to differences in frequency of chiasma formation within homologous regions.

With such large map distances recombination values reach 50 per cent, and at least one, namely, $50 \cdot 82 \pm 0 \cdot 42$ per cent between *scarlet* and *interrupted* venation, the loci of which are more than 86 units apart, is perhaps above 50 per cent. We have also discovered negative interference in connexion with a large inversion in the $X$-chromosome. The presence of a cross-over in the region immediately proximal to this inversion, so far from diminishing the frequency of cross-overs in the region immediately distal to it, increases it about twenty-fold. Multiple crossing-over is, of course, much more frequent than in *D. melanogaster*, and we possess considerable data concerning it.

The effect of inversions on crossing-over is also quantitatively different from that in *D. melanogaster*. Thus a single inversion covering about a third of the $X$-chromosome and reducing the map-length by at least 80 units gave only one internal double cross-over in 8,000 flies. A single inversion covering about 15 per cent of this chromosome, and lying between loci giving 32 per cent of recombination, did not reduce this percentage. This and other facts suggest that chiasmata are localized.

'Non-disjunction' of the sex chromosomes, causing the production of female pronuclei with two or no $X$-chromosomes, occurs once in about 7,000 oogeneses. But, as in *D. pseudoobscura*, $XXY$ females do not give $XX$ pronuclei with an appreciably higher frequency than $XX$ females.

Meiosis can be observed in male imagines of this and other Drosophila species (Philip[13]). The three sex chromosomes in $XYY$ males form a loose trivalent and segregate at random. A male of slightly abnormal phenotype and two normal males were trisomic for one of the long autosomes, a condition which is lethal in *D. melanogaster*.

We have found four flies mosaic for sex-linked genes. One appeared to be wholly female and three gynandromorphs. One of these had two ovaries and two testes, all fairly well developed, but not normal. All the mosaics were 'fore and aft' rather than bilateral, suggesting a pattern of cleavage somewhat different from that of *D. melanogaster*. A sex-linked eye colour which was non-autonomous in two out of three mosaics is probably homologous with *vermilion* in other species.

Unlike all other Drosophila species so far tested, *D. subobscura* will not mate in the dark. Since visual stimuli are essential for mating, several mutant forms with abnormal eye colours, including *white*, which, though phototropic, do not respond to moving contours (Kalmus[14]) are male-sterile. The mutant *yellow*, as in other species, has a cuticle abnormally permeable to water and other substances (Kalmus[15]) and is at a disadvantage in dry environments. In *D. subobscura* it is also at a disadvantage as a male in mating. Normal females generally kick off yellow males which attempt to copulate with them. Yellow females show no preference. But it is possible by selection to obtain a stock in which normal females are comparatively tolerant of yellow males, though the normal body colour is still preferred. Thus we have demonstrated not only sexual selection of a more or less Darwinian type, but also the inheritance of degrees of preference in the female, such as Darwin postulated.

It will be seen that this native European species differs from all animals so far described (if Sokolov and Dubinin's form and our own are conspecific) in being normally a structural heterozygote in both sexes. It is also very favourable material not only for comparative genetics, but for the study of chromosomes with long map distances, of polysomy, of the genetics of behaviour, and many other topics. We hope after the War to compare the British and Continental races. It is also to be hoped that it will be studied in several British centres, in order to investigate whether it possesses geographical races or other adaptations to the different conditions in various parts of Britain.

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[1] *J. Genet.*, **33**, 25 (1936).
[2] *J. Genet.*, **38**, 37 (1939).
[3] *J. Genet.*, **39**, 47 (1939).
[4] "Genetics".
[5] Drosophila Information Service, **15**, 39 (1941).
[6] *Z. Zellf. u. mikro. Anat.*, 26 (1937).
[7] "The New Systematics", 185 (Oxford: Clarendon Press, 1940).
[8] *Jap. J. Genet.*, 12 (1936).
[9] *J. Genet.*, **34**, 415 (1937).
[10] *Genetica*, **20**, 458 (1938).
[11] Carnegie Institution of Washington Pub., 399 (1929).
[12] Carnegie Institution of Washington Pub., 552 (1944).
[13] *Nature*, **149**, 527 (1942).
[14] *J. Genet.*, **45**, 206 (1943).
[15] *Proc. Roy. Soc.*, B, **130**, 185 (1941).

# HEALTH EDUCATION IN YOUTH SERVICE*

THE Central Council for Health Education, which is recognized by the Government as one of its agencies for health education, has thought it timely to outline the part that it considers health education should play in the youth service of the future.

The general standard of health in the community at present falls so far short of possibilities that there is obviously much room for improvement; and one of the ways in which it can be improved is through health education. Clearly, education alone will not be sufficient—there is needed also an improvement in community conditions (particularly in regard to housing and nutrition). But it is only through education that people can be encouraged to make the best use of conditions as they exist and be made aware of the possibilities of improving them.

Ideally, health education should be a way of living and something that is almost insensibly absorbed in the home, the school, the youth organization and the work place, rather than a formal subject taught in set sessions at set times. It has, however, at least three important aspects—the imparting of knowledge, the inculcation of habits and the encouragement of attitudes. Knowledge will not of itself lead to better health; but it provides the intellectual background to habits already acquired and helps in the development of healthy attitudes. Many of the most important health habits must be inculcated long before the child is capable of assimilating the knowledge which justifies them; but their practice should be reinforced by theoretical understanding as soon as possible. Attitudes are influenced by home environment from the very earliest days, and in particular by the way in which habit-training is carried out, but they also require intellectual understanding for their fullest development. These three aspects of health education are thus closely inter-related.

Knowledge important in health education includes an understanding of the structure and functioning of the body and of the relationship between physical and mental health. Important also is an understanding of how the spread of disease occurs and how it can be prevented or reduced; a grasp of the social factors influencing the health and well-being of the community; and a knowledge of the personal and social measures necessary to enhance health and build up resistance to disease.

The bodily habits relevant to health education include those consisting essentially of the disciplining of natural functions (for example, eating and voiding) and those others (for example, personal cleanliness) which are essentially habits of civilization. Equally important are the habits of the mind and of behaviour in relation to society.

Among the important attitudes are those of normality towards the body and its functions, deviating neither towards prudish avoidance nor towards prurient curiosity; of regarding health not as a mere absence of disease, but rather as a positive state of joyous well-being; and of feeling a sense of responsibility for the state of personal, family and community health.

Since young people do not enter within the scope of the youth service at the age of fourteen without having been influenced very considerably by their earlier training, any consideration of the type of health education appropriate to the period of adolescence is dependent upon the making of certain assumptions about what will have been achieved before this period is reached. It seems reasonable to assume that by the time children reach the age of fourteen, they will have received in home, school and juvenile organizations, health education along the three lines of imparting of knowledge, inculcation of habits and encouragement of attitudes indicated above, up to levels appropriate to their stage of development. The definition of these levels is in the main a matter for parents and teachers, and those responsible for the youth service will need to continue to build from the levels already reached.

## Health Education in Youth Service

The special functions of health education in adolescence would appear to be the reinforcement and widening of earlier education, especially in those directions most affected by the maturing ideals, emotions, experiences and activities of this period. With the statutory raising of the school-leaving age, some of this education will be given in the last year or two at school, and with the establishment of young people's colleges, some will be given during part-time compulsory education. The extra year or two of compulsory education would be most usefully employed in giving systematic instruction in those aspects of health education for which the adolescent is now sufficiently mature—in intellectual and emotional development and in social experience and awareness. For many young people, this will be the last opportunity for systematic instruction, and full advantage should be taken of it.

A great deal, however, will still remain as the special function of voluntary instructional classes and youth organizations.

The whole spirit of health education in youth service should be such as to encourage the development in adolescents of an appreciation of the possibilities of reaching a high standard of personal and community health and the growth of a sense of individual responsibility for reaching this standard. Certainly importance should be attached to the measures which are required from the State, the local authorities, etc.; but it needs emphasizing that increasing social provision should be accompanied by greater individual effort.

Adolescents particularly need help in meeting the peculiar problems of the period through which they

* Memorandum by the Central Council for Health Education.

are passing: in physical problems such as the coping with the bodily changes of adolescence; emotional problems such as those arising from the development of sexual interests and urges; and social problems such as those of the relations between the young people and their parents, between young men and young women, and between the individual and society.

The age-range covered by youth service is one in which young people are very interested in the development of physical fitness, strength, agility and grace; and any plans for health education should take full advantage of this interest. The keen desire to make oneself attractive to other people provides a very valuable opportunity for education in the care of the body generally and perhaps particularly in the attainment of grace and poise and in the care of the hair and complexion.

The period of adolescence is also one in which it is essential to give some training for approaching maturity. Examples of such training are marriage preparation, parentcraft, home economics, and instruction in the measures needed for the maintenance in full health of the individual, the family and the community.

It is clear that in most youth organizations very little will be possible in the way of systematic courses of instruction. Young people in their leisure hours wish for recreation, and lectures should be arranged mainly in response to demands made by the members themselves. The skilful teacher will be able to stimulate such demands—often as a result of informal discussions which make clear the need for further information on specific topics—and lectures which have been requested by the members are likely to be given much more attention than would have been the case had they been forced on the members by the leader.

But while it is true that the atmosphere and practice of the educational system will be a vital part of health education throughout, this is pre-eminently true of the youth organizations. The whole routine of the club—activities, toilet arrangements, concern for the cleanliness of premises and equipment, insistence that habits acquired in the organization are for everyday use and not 'for club night only', personal relationships between leaders and members and between one member and another—is of the utmost importance. Thus the encouragement of camping, rambling, youth hostels, etc., as well as the more formal type of physical recreation, is an essential part of health education.

The extent to which health education will be carried out in youth organizations will depend largely upon the degree to which the leaders are themselves educated, able to colour the whole life of their organization, and able and ready to stimulate and respond to demands for information. In addition, therefore, to those qualities of personality which are essential to any successful youth work, all leaders should be alive to the need for and the possibilities of health education, should themselves have a positive attitude to health and should have that necessary minimum of basic factual knowledge which will enable them to plan their programmes in the best way.

Moreover, each club or group of clubs should have at least one leader specially qualified in health education. This person might in many cases be the physical recreation instructor, in other cases the instructor in first aid and home nursing or allied subjects.

Ideally, too, each club would have a medical adviser—who would be available to advise the youth leaders and the young people upon matters within his province. It must be recognized, however, that this ideal will not be attained for a long time ahead, and it is therefore all the more important that meanwhile there should be a corps of fairly highly trained youth leaders (each of whom might serve a group of clubs) who, while naturally not attempting to carry out the work of a medical practitioner, would nevertheless be able to give the organizations covered by them skilled help and advice on the principles of healthy living. The Central Council for Health Education is able to give local authorities help in training youth leaders to carry out this work.

No amount of training will make good leaders out of poor material; but native abilities and aptitudes may be reinforced by courses of instruction. In the organization of such courses the Central Council for Health Education again can give considerable help, and indeed, regards the training of youth leaders as one of its most important tasks. It has already held many such courses and is developing co-operation with the Central Council of Physical Recreation so that theory and practice may march together.

In this connexion, it is worth considering the institution of a certificate in health education along lines somewhat similar to that in physical recreation, awarded at present by the Central Council of Physical Recreation. Youth leaders, like other students, are the more likely to give serious study to a matter when they are working for a test, and have a natural desire for some documentary evidence of the standard they have attained. The Central Council for Health Education hopes to discuss with the Board of Education and its Youth Advisory Council the desirability of such a certificate and the terms upon which it might be awarded to persons judged suitable from other points of view.

While it is true that the best youth leaders can do excellent work even in a very poor environment, it is equally true that a general high standard of achievement depends upon the availability of adequate accommodation and equipment. Club premises which, with proper cloakroom, lavatory and toilet accommodation, will reinforce, not contradict, health teaching; physical recreation apparatus, playing fields, camping sites, swimming pool, youth hostels—these are the basic material requirements. There is also particular need for a permanent residential school, with attached model club, in which, throughout the year, youth leaders from all parts of the country may gather for training and refresher courses, of which the theory and practice of health education should form an important part.

## THE PHILOSOPHY OF RESEARCH

THE American Philosophical Society arranged a symposium on the "Organisation, Direction and Support of Research" for its autumn meeting, held during November 19–20, 1943, and the papers presented have now been published (*Proc. Amer. Phil. Soc.*, 87, No. 4, January 29, 1944). Together they constitute a notable contribution to the philosophy of research, dealing on the whole with strategy rather than with tactics, and though concerned primarily with American conditions, they are highly relevant to the present discussions in Great Britain on the

organization of research, the functions of the universities, the relations between teaching and research and like problems.

The first paper, Dr. J. B. Conant's Franklin Medal Lecture on "The Advancement of Learning in the United States in the Post-war World", well illustrates the general validity of the symposium. Free inquiry, he points out, is the necessary condition for the advancement of learning in any age, but while welcoming the debate between the schools of Bernal and Polanyi on the planning of science, Dr. Conant urges that relevance, not utility, should be the touchstone: in each area of the entire field of learning, the activities under way must be manifestly relevant to the future of our civilization. Following the argument of Francis Bacon, he reminds us that we must not mistake the mere acquisition of information for an advance in knowledge, and strikes a note of caution about our understanding of the scientific method and its limitations which recurs frequently in the symposium. Only in situations where value judgments can be eliminated from the frame of reference are methods comparable to those used in the advancement of knowledge really applicable, and yet the difference between disciplined and well-informed judgments, involving values on one hand and on the other extravagant and ignorant opinion, marks the boundary between civilization and barbarism. Developing this distinction between accumulative knowledge and philosophy, Dr. Conant refers to the confusion between what is social science and what is social philosophy. He believes that, like the service of social science and the practice of the arts of democratic government, they are vocations which cannot be combined. A major share in both advancing learning and fostering philosophy will be the responsibility of the universities, though research institutes will play an important part, and whether or not professional education is combined with research, it is essential that our intellectual leaders be in close contact with the most promising youths of the oncoming generation. We need not organize institutions of higher education into a hierarchy; but we must make it an ambition of the people to foster the spirit of free inquiry. The unity of the world of pure learning is based, not on a common method, but on a common dedication.

Prof. H. S. Taylor's paper on "The Organisation, Direction and Support of Research in the Physical Sciences" covers more the problems considered in such reports as those of the Parliamentary and Scientific Committee on "Scientific Research and the Universities". After reviewing briefly the research structure in the United States, in Great Britain and in the U.S.S.R. and commenting on the relation between research and education—the immense needs for technological and scientific training must be balanced by competent education in the liberal arts and humane studies—he asserts that the problem of direction of research is a problem of personnel and is resolved when a competent director is found. The body responsible for such selection should consist primarily of scientific men, and breadth of interest within that body should help to promote wisdom of choice. In regard to the support of research, he points out that research workers and directors have local responsibilities which, if recognized, might well broaden the bases from which private support of research might come. As regards the support of fundamental research by industry, he looks to the prosecution of fundamental studies in research institutes, co-operatively supported, and concerned also with the dissemination of research information and the training in methods of research of specially selected personnel at the graduate student level for future positions of responsibility within the industry. Speaking of State and Government support of fundamental research, Prof. Taylor insists that scientific men must be masters in their own households; the processes of mutual co-operation and assistance among the individual sciences must be multiplied, and the isolation of one science from another must progressively diminish.

In his paper "The Discovery and Interpretation of Biological Phenomena", Dr. W. Bronk, like Dr. Conant, and Marjorie H. Nicholson in her subsequent paper on "Merchants of Light: Scholarship in Arts and Letters", draws fresh inspiration from Bacon, and discusses more particularly the influence of scientific societies and institutes on teaching and research. He stresses the need in our teaching for more concern with the generalizations and relationships of science, more attention to the analytical processes, and less to the description of phenomena, particularly in training biological investigators, and pleads for clear thinking about the impediments which certain of our scientific compartments offer to effective research, and the limitations they impose on the character of the training we give our future investigators.

No summary could do justice to this suggestive address, which is practical rather than philosophical, and much the same must be said of Alan Gregg's "A Critique of Medical Research". This is somewhat more philosophical and is concerned primarily with the strategy of medical research. Commenting on an important point made, for example, in the last annual report of the Carnegie Corporation of New York, that research funds are increasingly earmarked for specific purposes by the donors, so that experience in selecting research problems and projects is on the whole too infrequent in the medical schools, he insists that the right of choosing the subject to be studied, of planning and performing some crucial experiment, belongs not to the donor or the administrator but to the investigator himself. The essential pre-occupation of wise administrators is to create and to foster the circumstances, the human relationships, in which gifted men will be most productive and prodigal of their gifts; and besides the creation of fluid research funds Dr. Gregg suggests that the creation of readerships, or posts of equal pay and tenure to professorships, but without the traditions or connotation thereof, is urgently needed to correct that characteristic of American research in which ability in research is neutralized, sterilized or otherwise wasted by the existing demands of administration and teaching. As to probable directions and characteristics of medical research in the next few decades, he instances the study of the effect of differences of environment on genetically similar organisms, genetics, biophysics and chemotherapy.

Dr. K. K. Darrow, in much the shortest paper, contributes a few crisp comments including a defence of the present system; while much the longest paper is that by H. A. Innis on "Political Economy in the Modern State". This is a major contribution to the debate to which Prof. F. Hayek's "The Road to Serfdom" has recently contributed in Great Britain, and Mr. Innis's extensive quotations from Mark Pattison may well set the contestants searching that writer anew. This sound philosophical paper has its place also in the discussion on the place of the universities

and their functions, and in Roy F. Nichol's paper on "War and Research in Social Science", Prof. R. L. Schuyler's paper on "War and Historiography" and Marjorie Nicholson's paper, there are stimulating comments and contributions to the fundamental thinking and philosophy on which alone the wise organization and direction of scientific research can be based.

# OBITUARIES

## Prof. W. E. H. Berwick

WILLIAM EDWARD HODGSON BERWICK, who died at Bangor on May 13, 1944, was professor of mathematics in the University College of North Wales from 1926 until his retirement, due to ill-health, in 1941. The title of emeritus professor was then conferred upon him by the University of Wales.

Berwick was born at Bradford on March 11, 1888, and was educated at Bradford Grammar School and at Clare College, Cambridge, of which he was a scholar from 1906 until 1910. He was bracketed Fourth Wrangler with C. G. Darwin and G. H. Livens in the Tripos of 1909 (the last year of the order of merit). In 1910 he was placed in the first class of Part II of the Tripos, and he was a Smith's Prizeman in 1911. His mathematical distinction was later recognized by a fellowship at his old College (1921–24) and by a Cambridge Sc.D. in 1925.

After two years as assistant lecturer at Bristol, Berwick went to Bangor as assistant lecturer and afterwards lecturer. Here he remained until 1920, except for two years spent in the anti-aircraft experimental section of the Munitions Inventions Department. At Bangor he had a congenial colleague in G. B. Mathews, who for many years had been almost the only worker on number-theory in England. From Bangor, Berwick went to Leeds, as lecturer and afterwards reader in mathematical analysis. He was appointed to the chair at Bangor in 1926. Shortly after this, his health began to deteriorate, but he struggled with great courage and fortitude, against increasing disabilities, to continue his teaching work and research.

Berwick's mathematical activity was concerned entirely with number-theory, the theory of equations, and topics arising out of them. His main publication was a Cambridge tract, "Integral Bases", in which he developed methods for determining an integral basis for any algebraic number-field. In particular, such a basis is determined for the field defined by $\sqrt[n]{a}$. This required the discussion of twenty-three separate cases, depending on the nature of the common factors of $n$ and $a$. The tract is a substantial contribution to algebraic number-theory, and it exhibits Berwick's interest in, and remarkable talent for, difficult enumerations and calculations. This talent was also shown in his calculations dealing with the complex multiplication of the elliptic functions.

Berwick also edited a second edition of Mathews' tract on "Algebraic Equations", to which he added appreciably. He published a number of original papers on complex multiplication and on the resolvents of quintic and sextic equations. He gave a good exposition of the latter subject in a lecture to the London Mathematical Society (printed in the *Journal*, **3**; 1928).

Prof. Berwick leaves a widow, to whom all sympathy is due.

H. DAVENPORT.

We regret to announce the following deaths:

Lieut.-Colonel L. F. Goodwin, professor of industrial chemistry and chemical engineering in the Queen's University, Kingston, Ontario, on August 15.

Prof. G. F. Stout, during 1903–36 professor of logic and metaphysics in the University of St. Andrews, on August 18, aged eighty-four.

# NEWS and VIEWS

## Mathematics at Bedford College, London: Retirement of Prof. Harold Simpson

PROF. HAROLD SIMPSON retires from the chair of mathematics at Bedford College, University of London, at the end of the present session. After a distinguished career at Oxford and a short period at Bangor, North Wales, he became head of the Mathematics Department at Bedford College in 1907 and was appointed professor there in 1912. Prof. Simpson has contributed many important articles on various topics to mathematical and scientific periodicals; in addition, he has written four valuable books. (These have appeared under the name Hilton, which Prof. Simpson gave up in 1939.) The first of these, on "Mathematical Crystallography", appeared in 1903, and his interest in this application of mathematics continues; he has served on the council of the Mineralogical Society on various occasions since 1908 and often attended the meetings of the Geology Section of the British Association. His next books, on "Finite Groups" (1907) and "Homogeneous Linear Substitutions" (1914), are in certain respects an almost essential complement to his first, having regard to the state of algebraic knowledge in Britain at the time. His other book, "Algebraic Plane Curves" (1920, 1932), is well known both to teachers and to students. Prof. Simpson has served on the council of the London Mathematical Society since 1915 and has been librarian since 1925.

Prof. Simpson played a very active and useful part in the affairs of the University of London. In particular, his colleagues will remember the skill and patience which he exercised in dealing with the business of the various committees with which he was concerned. Many hundreds of students of Bedford College will remember with gratitude his exceptional ability as a teacher; his sympathetic and understanding nature was particularly apparent to those students not so gifted in his subject, but all regard him with affection. Outside his own subject and in addition to his interest in geology, Prof. Simpson was deeply interested in architecture and in music. Students at Bedford College will remember the excursions he organized for them to various centres of architectural interest and his activities with them in the College Musical Society.

## Appointment of Dr. W. N. Bailey

DR. W. N. BAILEY, Richardson lecturer in pure mathematics in the University of Manchester, has been appointed to the University chair of mathematics at Bedford College, London. He is perhaps

best known for his work on the theory of generalized hypergeometric series; much of this was incorporated in his Cambridge 'tract' on this subject, an excellent booklet which makes pleasant reading. To him are due two new methods of obtaining transformations of such series; one is algebraic and the other uses contour integrals of Barnes' type. These methods led to various generalizations in the theory, and applications were made to Bessel functions and Legendre functions. Some of his most important work in this field concerned infinite integrals in which the integrand involved the product of three Bessel functions. The argument used an earlier result of his, that Appells' hypergeometric function of two variables could in a particular case be expressed as a product of two ordinary hypergeometric functions. This case has since been of use to other writers and has led to new researches. His most recent work, which is in process of publication, is on the problem of finding transformations of hypergeometric series of both the ordinary and the basic type. Previously, no general method of obtaining transformations of basic series had been given. His new point of view has led to new transformations of basic series, thrown further light upon them and has also led to numerous identities of the Rogers–Ramanujan type.

## Science and Industry at Manchester

THE Manchester Chamber of Commerce has done well to issue in pamphlet form (Pp. 63. 1*s.* 6*d.*) the addresses given at the four meetings on "Science and Industry" in March and April last. The pamphlet contains not only the addresses of Lord Riverdale, Dr. A. P. M. Fleming, Dr. Andrew McCance and Sir Edward Appleton, which have already been noted in these columns, but also other addresses given at the meetings, such as those of Sir Raymond Streat, Mr. A. H. S. Hinchcliffe, announcing the formation of a Joint Standing Council of the Chamber and of the University of Manchester, Mr. C. C. Renold and Mr. R. H. Dobson. Mr. C. C. Renold, following Dr. Fleming's address on "Research Workers: their Education and their Place in Industry", referred particularly to the traditional industries where the application of science should involve challenging the traditions themselves, not merely tuning them up or their further evolution. The emphasis should be on the application of what is already known rather than the extension of the boundaries of knowledge, and Mr. Renold suggested that for the medium-sized traditional concern the key move is the appointment of a scientific liaison officer with broad and general rather than specialized scientific qualifications. His job should be to recognize the problems and indicate lines worthy of investigation, and to help the practical men to apply the answers. With this fairly high-ranking appointment in the management, a re-casting of management structure might also be necessary to separate those functions of management which lend themselves to contact with the scientific liaison officer and thereby provide a convenient channel for his influence to become effective. Some re-casting of the accepted curricula of teaching may be required to provide men of the necessary breadth of scientific appreciation. Mr. R. H. Dobson, following Dr. McCance's paper on the application of research, referred to the bearing of fundamental research on the export trade of Britain, and to the necessity of creating a liaison and a free interchange of ideas and work between technical assistants and the people on the shop floors.

## Looting of Simeis Observatory

A TELEGRAM received at the Royal Observatory, Greenwich, from G. A. Shajn, member of the Academy of Sciences of the U.S.S.R., gives an account of the fate suffered at the hands of the enemy by the Simeis Observatory in the Crimea. A week or two before the Germans occupied the southern part of the Crimea, the staff of the Observatory was evacuated, the workers taking with them the object glasses of the two astrographs and part of the laboratory equipment. In May 1944, after the Crimea had been liberated by the Red Army, the Academy of Sciences sent Dr. Shajn to inspect the remains of the Observatory. He established the following facts. During September and October 1943 German specialists dismantled all the Observatory's instruments and moved them in thirty or more trucks to Simferopol, whence they were dispatched to Germany. The equipment stolen was the 40-in. reflecting telescope, the double astrograph, a new astrograph for zonal observations, a photoheliograph, three stellar spectrographs, a large cœlostat, a long-screw measuring machine, a Repsold machine, a microphotometer and two astronomical clocks.

In addition to this, much other laboratory equipment and the whole library collection of more than nine thousand negatives, and the equipment of the power station and workshop were all taken away. The wooden parts of three observatory domes were destroyed, and one of them was used as a stable. The wooden building which housed the spectrohelioscope was also destroyed, as were a number of other pavilions. On January 18, 1944, the main building of the Observatory, where a Rumanian army unit was quartered, caught fire. It continued to burn for two days, but the commander of the unit did not call out the fire brigade nor did he take any steps to extinguish the flames. British men of science will sympathize with Russian astronomers in the looting and wanton destruction of this famous Observatory.

## Tropical Diseases Investigation in New York

A RECENT article in *Nature* (May 9, 1944, p. 625) referred to the part played by parasitic diseases in war and to the realization by American physicians that these diseases constitute a grave danger to their troops overseas. Prof. H. W. Stunkard (*Ann. New York Acad. Sci.*, 44, Art. 3, 189; 1943) has referred to the absence of adequate instruction in tropical medicine or of any institution devoted primarily to work on parasitic diseases in the United States. Nuttall, Brumpt and Fülleborn, he states, thought that New York should provide the financial support for such an institution, because it is the principal shipping and commercial centre in the United States. In time of war, Prof. Stunkard points out, it is one of the chief ports of embarkation and disembarkation, so that there is acute need there for diagnostic, therapeutic and research work. The Columbia University Department of Public Information now announces that plans are being formulated which will, if they are carried out, make New York City a world centre of teaching and research in tropical medicine. Dr. H. S. Mustard, director of the DeLamar Institute of Public Health, Columbia University School of Medicine, states that a substantial beginning has been made, thanks to a temporary grant from the Macy Foundation. An additional grant from the John and Mary H. Markle

Foundation has been received for research on filariasis. Instruction in tropical medicine for medical students has been increased at the Institute, and its laboratories are now available to officers of the armed services and to others who need to go to the tropics. Intensive courses for graduates are also being provided and it is expected that very soon a full year's course will be available. There is hope that new buildings will be possible soon after the War.

Dr. Mustard echoes Prof. Stunkard's words when he says that ". . . the very business of war depends upon a successful combating of tropical diseases". Not only is the health of the fighting forces concerned, but also that of local populations in the tropics who are required for getting raw materials, building airfields and general labour. Alliances, treaties and national and trade interests are more than ever taking United States Government officials, business men and others to the tropics by ship and aeroplane, and these men, ships and aeroplanes may bring back tropical diseases and their vectors. "The universities of the United States cannot remain aloof from the realities of this situation," says Dr. Mustard. Only a few United States universities, he states, will be able to offer courses in tropical medicine, the number being limited by their position and resources. A university giving such courses should be in a great city which is a great centre of rail, sea and air transit, especially transit to and from the tropics; and it should be a recognized cultural, educational and medical centre and have international prestige and an outstanding school of medicine. Columbia University in New York City, with its unique relation with the School of Tropical Medicine at Puerto Rico and with the College of Physicians and Surgeons, would certainly seem, as Dr. Mustard suggests, to be well fitted to undertake this vitally important work.

## Solar Research in Belgium during 1942

A NOTE on this subject by Swings (*Astrophys. J.*, 99, 118; 1944) reports that the University of Liége still continues its programme of astronomical infra-red spectroscopy, and that in June 1942 a new self-recording high-dispersion spectrograph was installed in the constant-temperature basement of the solar tower. This instrument utilizes four plane echelette gratings with 15,000, 3,600, 2,400 and 1,200 lines per inch respectively, the whole spectrum from 1 $\mu$ to 20 $\mu$ being covered with a resolving power which will separate lines 1 cm.$^{-1}$ apart. A preliminary paper by Migeotte gives a general account of the results obtained from recordings of the solar spectrum in the region near 1·5 $\mu$. Here absorption lines only 1·5 A. apart can be separated, and the distinction between solar and telluric lines is relatively simple. A study of the water-vapour spectrum in this region is nearing completion, and the new instrument is now in continuous operation.

## Research in the Caribbean

PROF. J. L. SIMONSEN, director of research of the Colonial Products Research Council, Sir Robert Robinson, Waynflete professor of chemistry in the University of Oxford, and a member of the Council, are now on a visit to the Caribbean area, where they are discussing fundamental problems of research on new uses for Colonial raw materials, with specific reference to the co-ordination of the work of the Colonial Products Research Council with that of the Caribbean Research Council.

## Biography of the late Lord Cadman, F.R.S.

MR. IVOR EVANS has been entrusted with the writing of the biography of the late Lord Cadman. Readers of *Nature* possessing letters, etc., likely to be of interest are asked to forward them to Mr. Evans, c/o Mr. James Cadman, Walton Hall, Eccleshall, Staffs.

## Night Sky in September

FULL moon occurs on Sept. 2d. 20h. 21m. U.T. and new moon on Sept. 17d. 12h. 37m. The following conjunctions with the moon take place: Sept. 11d. 06h., Saturn 0·7° N.; Sept. 16d. 01h., Mercury 5° S.; Sept. 16d. 08h., Jupiter 3° S.; Sept. 19d. 00h., Mars 5° S.; Sept. 19d. 11h., Venus 5° S. In addition to the above, the following planetary conjunctions also take place: Sept. 10d. 02h., Venus in conjunction with Mars, Venus 0·5° N.; Sept. 23d. 16h., Mercury in conjunction with Jupiter, Mercury 0·1° N. Mercury is in inferior conjunction on Sept. 6, stationary on Sept. 15, and attains its greatest western elongation on Sept. 22. The times of rising of the planet at the beginning, middle and end of the month are 6h. 31m., 4h. 15m., and 4h. 32m. respectively. Venus sets at 19h. 29m., 18h. 48m., and 18h. 23m. at the beginning, middle and end of the month, and is not very well placed for observation. Mars and Jupiter are too near the sun for favourable observation. Saturn can be seen late at night or in the early morning hours; at the end of September the planet rises at 22h. The autumn equinox commences on Sept. 23d. 04h.

## Announcements

MR. C. T. GIMINGHAM has been promoted to the post of director of the Plant Pathology Laboratory of the Ministry of Agriculture and Fisheries at Harpenden, to succeed Mr. J. C. F. Fryer, who has been appointed secretary to the Agricultural Research Council.

THE Council of the Institution of Electrical Engineers has decided to continue for the present session the scheme for the admission of non-members of the Institution to any technical meeting of the Institution. Anyone who considers that his technical experience and educational attainments do not suffice to admit him to any form of Institution membership, but who nevertheless wishes to attend meetings of the Institution, can obtain from the secretary an application form, on the completion of which and on payment of a fee of 10*s*. to cover administrative costs, he will receive notices of meetings and an invitation card which will serve as a title of admission.

DR. G. LAPAGE writes: "May I correct an error in my abstract, entitled 'A Flatworm Parasite of Freshwater Trout', of the paper by J. B. Duguid and E. M. Sheppard, printed in *Nature* of Aug. 5 (p. 185). My abstract implied that Duguid and Sheppard concluded from material sent to them by Dr. Peterson, of Yell, that *Diphyllobothrium latum* is endemic in freshwater trout in the Shetlands. What these authors actually say is that 'from material kindly sent to us by Dr. Peterson of Yell, we gather that a species of Diphyllobothrium is endemic among freshwater trout in certain of the Shetland Islands'. This is, of course, very different from the statement which I attributed to them and would refer, presumably, to the larval stages".

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Penicillin-like Antibiotics from Various Species of Moulds

SINCE the demonstration of the biological and chemical properties of penicillin, an antibiotic produced by *Penicillium notatum*[1,2,3,4,5], certain other species of moulds have been shown to produce similar substances—*Aspergillus flavus*[6,7,8,9], *A. giganteus* Wehm[10], and *A. parasiticus*[11].

In the course of an investigation of moulds that have been shown by Wilkins and Harris[12,13,14] to produce antibiotics, we have found that in addition to the above-mentioned species penicillin-like substances are produced by the following:

| | National collection of type cultures No. |
|---|---|
| *P. fluorescens* .. .. .. | 6621 |
| *P. rubens* Biourge .. .. .. | 6643 |
| *P. avellaneum* Thom and Turesson | 3751 |
| *P. baculatum* Westl. .. .. .. | 3956 |
| *P. turbatum* Westl. .. .. .. | 6523 |

Of these, *P. baculatum* and *P. rubens* are morphologically similar to, and therefore possibly related to, the *chrysogenum-notatum* group, but the others are quite widely separated morphologically from that group and from each other (personal communication from Dr. W. H. Wilkins).

The antibacterial activity developed in a variety of media, including in each instance modified Czapek Dox[2], with and without corn steep liquor.

The penicillin-like nature of the antibiotic was established by the following biological and chemical properties: active against *St. aureus*, not against *B. coli*; extracted into organic solvents at $pH$ 2 and re-extracted with water at $pH$ 7; inactivated by acid and alkali; partially inactivated by heating at 100° C. at $pH$ 7 for 15 minutes; completely inactivated by penicillinase and by copper ions; all except the product of *P. turbatum*, which was not tested, were inactivated by methyl alcohol. (Some of the inactivation tests on the product of *P. baculatum* were carried out by Dr. E. Chain. We are indebted to Dr. E. S. Duthie for preparations of penicillinase.)

Thus it is becoming apparent that many species of moulds produce penicillin-like substances.

H. W. FLOREY.
N. G. HEATLEY.
M. A. JENNINGS.
T. I. WILLIAMS.
Sir William Dunn School of Pathology,
University of Oxford.
July 28.

[1] Fleming, A., *Brit. J. Exp. Path.*, 10, 226 (1929).
[2] Clutterbuck, P. W., Lovell, R., and Raistrick, H., *Biochem. J.*, 26, 1907 (1932).
[3] Reid, R. D., *J. Bact.*, 29, 215 (1935).
[4] Chain, E., Florey, H. W., Gardner, A. D., Heatley, N. G., Jennings, M. A., Orr-Ewing, J., and Sanders, A. G., *Lancet*, 2, 226 (1940).
[5] Abraham, E. P., Chain, E., Fletcher, C. M., Florey, H. W., Gardner, A. D., Heatley, N. G., and Jennings, M. A., *Lancet*, 2, 177 (1941).
[6] Bush, M. T., and Goth, A., *J. Pharm. Exp. Therap.*, 78, 164 (1943).
[7] Waksman, S. A., and Bugie, E., *Proc. Nat. Acad. Sci.*, 29, 282 (1943).
[8] McKee, C. M., and MacPhillamy, H. B., *Proc. Soc. Exp. Biol., N.Y.*, 53, 247 (1943).
[9] McKee, C. M., Rake, G., and Houck, C. L., *J. Bact.*, 47, 187 (1944).
[10] Philpot, F. J., *Nature*, 152, 725 (1943).
[11] Cook, A. H., and Lacey, M. S., *Nature*, 153, 460 (1944).
[12] Wilkins, W. H., and Harris, G. C. M., *Brit. J. Exp. Path.*, 23, 166 (1942).
[13] Wilkins, W. H., and Harris, G. C. M., *Brit. J. Exp. Path.*, 24, 141 (1943).
[14] Wilkins, W. H., and Harris, G. C. M., in the Press.

## Organic Accelerators for Enzyme Systems

IN order to determine the part played by yeast extracts in the stimulation of the respiration of various cells[1], a study was made on the possible antagonism between this respiratory stimulant and several well-known respiratory depressants. The poisons, potassium cyanide, sodium azide, amyl alcohol and urethane, react reversibly or irreversibly with particular enzyme systems of the respiratory chain. Potassium cyanide and sodium azide depress the activity of the iron oxidation catalysts, while amyl alcohol and urethane react with the dehydrogenating system.

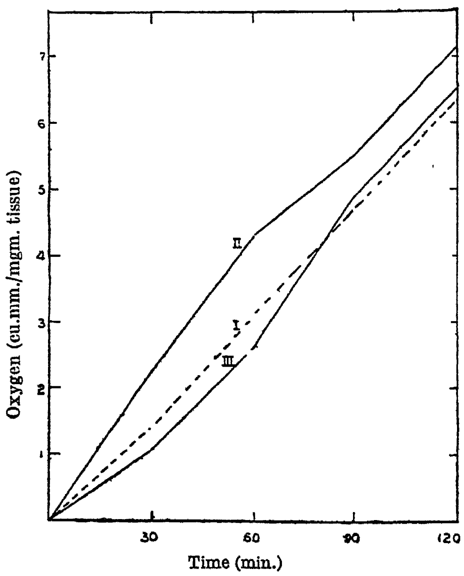


Fig. 1. EFFECTS OF YEAST EXTRACT AND SODIUM AZIDE ON RAT LIVER RESPIRATION
Curve I, control. Curve II, yeast extract initially present and sodium azide added at 60 min. Curve III, sodium azide initially present and yeast extract added at 60 min.

In Fig. 1 is shown the antagonism between yeast extract (6 mgm./ml.) and $M/1,050$ sodium azide on rat liver respiration. The oxygen uptake was determined in Ringer-phosphate glucose solution at a temperature of 37·5° C.[1]. In one set of experiments, 1 ml. of yeast extract (18 mgm./ml.) dissolved in Ringer-phosphate glucose was placed in the flask at the beginning of the experiment. Addition after 60 minutes of 1 ml. of $M/350$ sodium azide in Ringer-phosphate glucose offset the stimulation caused by the extract and brought the rate of oxygen uptake back to that of the control. In the other set of experiments, the depression of respiration due to sodium azide was offset completely when 1 ml. of yeast extract was added from the side arm. Qualitatively similar results were obtained with potassium cyanide. No antagonism could be found between the yeast extract and poisons such as amyl alcohol and urethane. We suggest, therefore, that the yeast extract stimulation occurs at the same part of the chain blocked by cyanide and azide, namely, cytochrome oxidase. Yeast and rat skin have behaved in a manner qualitatively similar to liver.

Since cytochrome oxidase is known to be an iron porphyrin enzyme containing a hæmin-like prosthetic group, it was thought desirable to study more closely the activity of the yeast extracts on simpler systems containing such iron enzymes as horse radish root

peroxidase and liver catalase. In the accompanying table is given the results of the sodium azide–yeast extract antagonism on the oxidation of pyrogallol by peroxidase.

ANTAGONISTIC EFFECTS OF SODIUM AZIDE AND YEAST EXTRACT ON PEROXIDASE ACTIVITY.

| Flask | Total purpurogallin produced (mgm.) | P.N. |
|---|---|---|
| I. Control .. .. .. .. | 16·0 | |
| | 16·2 | 0·21 |
| II. Control, yeast extract (1·5 gm.) .. | 20·5 | 0·27 |
| III. Control, 1 ml. sodium azide (0·50 *M*) .. .. .. | 10·2 | 0·13 |
| IV. Control, yeast extract, sodium azide .. .. .. .. | 14·5 | 0·19 |

The method used in determining peroxidase activity was that of Willstätter modified by Bancroft and Elliott[2]. The yeast extract partially offset the sodium azide depression and accelerated the purpurogallin production approximately 26 per cent above control. The extract was much more effective against potassium cyanide. The depression caused by lower concentrations of both poisons could be offset completely by the extract. The extract exerted a slight but definite peroxidase action in the absence of added enzyme.

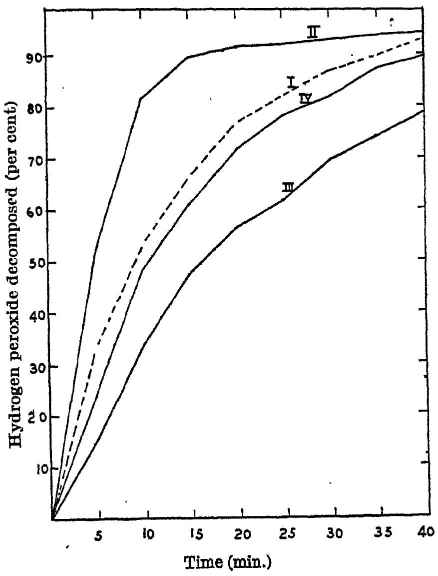


Fig. 2. EFFECTS OF YEAST EXTRACT AND POTASSIUM CYANIDE ON DECOMPOSITION OF HYDROGEN PEROXIDE BY CATALASE.
Curve I, control. Curve II, control + yeast extract. Curve III, control + potassium cyanide. Curve IV, control + potassium cyanide + yeast extract.

In Fig. 2 is shown the stimulation of hydrogen peroxide decomposition by catalase in the presence of the extract, and also the ability of the extract to antagonize the potassium cyanide depression. The method employed for the calculation of catalase activity was that of Euler and Josephson[3]. Concentrations of yeast extract and potassium cyanide were 1 mgm./ml. and $2{\cdot}5 \times 10^{-3}$ *M*., respectively. The yeast extract did not decompose hydrogen peroxide in the absence of catalase.

The experiments on peroxidase and catalase indicate that the yeast extract did not function as substrate for the enzymes. It did not possess catalase activity in itself and showed but a very slight peroxidase activity. Significantly increased activities were observed only in the presence of the enzymes. The yeast extract may be considered to contain organic accelerators for iron porphyrin enzymes. It is suggested that the extract contains organic iron compounds the molecular size of which lies somewhere between iron sulphate and hæmin, and which can function as additional prosthetic groups for the protein of the enzyme (apoenzyme). This possibility is being investigated.

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[1] Cook, E. S., Kreke, C. W., and Nutini, L. G., *Studies Inst. Divi Thomae*, **2**, 23 (1938).
[2] Bancroft, G., and Elliott, K. A. C., *Biochem. J.*, **28**, 1911 (1943).
[3] Von Euler, H., and Josephson, K., *Liebigs Ann.*, **452**, 158 (1927).

## Effect of Caramelized Fructose on the Stability of *l*-Ascorbic Acid

THE investigation of the effect of caramelized fructose on the stability of *l*-ascorbic acid was suggested by the demonstration that caramelization of lemonade powders at high storage temperatures was due to fructose which was formed from sucrose by hydrolysis, made possible by the liberation of water of crystallization of citric acid[1]; and also by the fact that a darkening of colour and a loss of ascorbic acid are associated changes in orange juice concentrate, although the relationship between the two processes is by no means clear.

That this matter may be important in relation to the deterioration of foodstuffs in warm climates is indicated by the fact that, at 98° F. (36·7° C.) and higher temperatures, pure fructose (both solid and aqueous solution) caramelizes spontaneously. As circumstances will not allow of the completion of this work for some time, it was deemed of sufficient interest and possible importance to merit a short statement.

A sample of B.D.H. fructose which had caramelized on keeping was used for the tests carried out under aerobic conditions reported below. A 1 per cent aqueous solution gave a galvanometer reading of 81 with an Evelyn photo-electric colorimeter. Tests—chiefly under anaerobic conditions—were also carried out with samples of Kahlbaum and of Baird and Tatlock fructose which had likewise caramelized on keeping. 1 per cent solutions gave galvanometer readings of 75 and 23 respectively. Pure fructose was prepared by recrystallizing from an alcoholic solution which had been treated with Merck pulverized animal charcoal until all traces of colour had been removed.

Ascorbic acid was estimated by titrating with 2:6-dichlorophenolindophenol, which was not reduced by the samples of caramelized fructose used. This is in contrast to the products of caramelization brought about by the action of alkali[2].

Glassware and materials were sterilized except for ascorbic acid and fructose. This was necessary owing to the liability to bacterial and fungal infection, especially in the solutions containing pure fructose and ascorbic acid.

10 per cent solutions of pure and of caramelized fructose were made up to contain 50 mgm. ascorbic acid per 100 c.c. solution. About 24 c.c. solution was put into 50 c.c. stoppered containers. Thus the available oxygen was much in excess of the amount

needed to oxidize the 13 mgm. ascorbic acid present, since complete oxidation would need less than 1 c.c. of oxygen. Also the containers were opened up at intervals for titration.

In most of the tests the solutions were stored at 50° F. (10° C.). The rate of loss of ascorbic acid was found to be too rapid for convenience at 85° F. (29·4° C.).

The accompanying table summarizes the results of a number of experiments. It is clear that there is a greater loss of ascorbic acid in solutions of caramelized fructose than in solutions of pure fructose. The contrast is emphasized by the direct comparisons for the second, tenth and seventeenth day intervals.

PER CENT LOSS OF ASCORBIC ACID UNDER AEROBIC CONDITIONS AT 50° F. (10° C.).

| Days | Pure fructose | Caramelized fructose |
|---|---|---|
| 2 | 3·1 | 32·9 |
| 5 | — | 46·6 |
| 7 | 12·3 | — |
| 8 | — | 68·5 |
| 10 | 18·65 | 75·2 |
| 14 | 20·3 | — |
| 17 | 31·0 | 100·0 |

The question naturally arises as to whether caramelized fructose has a destructive effect on ascorbic acid under anaerobic conditions. Tests, using various techniques, were carried out with the three samples of caramelized fructose mentioned above. The results so far obtained are not sufficiently precise to merit detailed statement; taken by and large, however, there can be little doubt of a destructive effect, but it is also clear that the rate of destruction is very much slower. The destructive effect under anaerobic conditions is also indicated by the decided differences in rate of loss of ascorbic acid brought about by the different samples of caramelized fructose under anaerobic conditions.

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[1] Isaac, Wm. Edwyn, "Storage of Synthetic Citrus Powders", *Ind. Eng. Chem.*, **35**, 470 (1943).
[2] Harris, L. J., *Nature*, **132**, 27 (1933).

## Production and Release of Nicotinamide by the Intestinal Flora in Man

AN investigation into the daily elimination of nicotinamide methochloride in healthy human beings[1] revealed a considerable discrepancy between this elimination and the daily intake of nicotinamide on current diets, as calculated from assays by Williams[2] in the United States and Kodicek[3] in Great Britain. Najjar and Holt[4] have shown that aneurin can be produced by the intestinal flora, which is thus capable of influencing the aneurin household of the body in a decisive manner. These findings suggested a similar mechanism for the production of that part of the nicotinamide which cannot be accounted for from the daily food intake.

This possibility was examined in a preliminary experiment by 'sterilizing' the alimentary tract of two persons with sulphaguanidine. The elimination of nicotinamide methochloride was estimated before, during and after the dosing period. A considerable drop in the nicotinamide methochloride elimination occurred during the dosage. We then proceeded to investigate this effect on a larger scale with eight volunteers. Five persons (three healthy and two chronic pellagrins) were given succinyl-sulphathiazole, while three persons (two healthy and one chronic pellagrin) received sulphathiazole to serve as a control. Diet and environmental conditions were uniform throughout the whole experimental period. The daily nicotinamide methochloride output was estimated before, during and after the treatment, blood and urinary levels of sulphathiazole were determined and test doses of nicotinamide were given twice to each subject, at the end of the dosing period and a week later, once orally and once parenterally.

The following points emerge from these experiments:

(*a*) There was a sharp drop of nicotinamide methochloride elimination during dosage with succinylsulphathiazole from the first day of dosing onwards, while the control group on sulphathiazole showed no significant change. The extent of the decrease in the nicotinamide methochloride output varied individually between 50 and 100 per cent, probably with the degree of sterilization of the intestines. The reduction in methochloride output was greater with succinylsulphathiazole than with sulphaguanidine and amounted on the average to 70 per cent in the healthy and 95 per cent in the pellagrous subjects.

(*b*) Sulphathiazole levels in blood and urines were considerably higher in the control group. The possibility of a direct interference of sulphathiazole with the nicotinamide metabolism is therefore excluded.

(*c*) Nicotinamide given at the end of the dosing period produced the usual rise in methochloride elimination in the healthy subjects, which proved that the formation of nicotinamide methochloride is not impaired by the drugs administered.

(*d*) The responses to nicotinamide administration varied according to the mode of administration; five subjects, including all three pellagrins, showing lower responses to the oral dose than to subcutaneous injection. The considerably lower response to oral dosage in all three pellagrins points to an absorption defect, a factor which has long been regarded as one of the causes of pellagra[5].

The most obvious interpretation of the marked reduction in nicotinamide methochloride output during administration of sulphaguanidine and succinylsulphathiazole is to assume that normally a synthesis and release of the vitamin by the intestinal flora takes place, and that this mechanism is impaired by the bacteriostatic action of the drugs. It is improbable that the drop in nicotinamide methochloride elimination could have been due to greater utilization of nicotinamide, since more sulphathiazole was circulating in the subjects receiving sulphathiazole, who showed no decrease in methochloride output, than in those receiving succinyl-sulphathiazole.

The gap between the dietary intake of nicotinamide and the elimination of nicotinamide methochloride referred to above appears, therefore, to be filled by the nicotinamide produced and released by the intestinal flora. Furthermore, it seems from present and previous work[1] that the quantity thus provided for human utilization can amount to as much as 80 per cent of the daily uptake.

This new factor is capable of explaining a number of previously reported inconsistencies in the etiology and therapy of nicotinamide deficiency diseases, particularly of pellagra. Roussel[6] and later Goldberger[7] and many others have insisted on the pellagra-preventive action of milk and milk products, which are notoriously poor in nicotinic acid[8]. Conversely,

maize, which is the staple food of many districts where pellagra is endemic, is not more deficient in nicotinic acid than wheat[8]. These paradoxes could easily be explained by assuming a primary effect of these foods on the intestinal flora. Thus, taking the case of milk, the following mechanisms may be involved.

(1) Milk protein provides the necessary building-stones for the bacterial synthesis of nicotinamide. This would appear possible in view of the work of Bovarnick[9], who demonstrated that mixtures of certain amino-acids and organic amides, which are present in significant amounts in milk protein, yield nicotinamide when heated.

(2) Milk as such provides a favourable nutritional medium for some types of intestinal bacteria, with a consequent increase in their general activity, including vitamin synthesis.

(3) Milk, by influencing certain physico-chemical factors, such as $pH$, favours the development of some particular strains of the intestinal flora responsible for the production of nicotinamide.

Maize, on the other hand, might produce the opposite effect on the intestinal micro-organisms.

Regarding nicotinamide deficiencies other than classical pellagra, particularly the acute confusional states described by Cleckley, Sydenstricker and Geeslin[10] in America and Gottlieb[11] in Great Britain, the suggestion by one of us (R. B.[12]) that confusional complications following sulphaguanidine therapy might have been due to a temporary aneurin deficiency should now be implemented by postulating an even more likely occurrence of an acute nicotinamide deficiency.

The literature contains numerous references to rashes following sulphaguanidine and succinylsulphathiazole therapy. While most of them have undoubtedly an allergic basis, a number have been put down to other causes and have even been likened to pellagrous dermatitis[13].

On the basis of our findings we would also like to endorse Najjar and Holt's[4] suggestion that the use of sterilizing sulphonamide drugs requires careful attention to the vitamin B status of the patient.

A detailed report of these experiments will be published elsewhere.

We are indebted to Dr. W. A. Caldwell for permission to carry out the larger experiment at West Park Hospital, Epsom, and Dr. S. W. Hardwick for the clinical care of the subjects under investigation.

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[1] Ellinger, P., and Coulson, R. A., *Biochem. J.*, in the Press.
[2] Williams, R. J., *J. Amer. Med. Assoc.*, **119**, 1 (1942).
[3] Kodicek, E., *Lancet*, i, 380 (1942).
[4] Najjar, V. A., and Holt, jun., L. E., *J. Amer. Med. Assoc.*, **123**, 683 (1943).
[5] Ellinger, P., Hassan, A., and Taha, M. M., *Lancet*, ii, 755 (1937).
[6] Roussel, J., "La Pellagra" (Paris, 1845), quoted from "Vitamins", Medical Research Council Report (1932).
[7] Goldberger, J., Waring, C. H., and Willets, D. G., *Pub. Health Rep. Wash.*, **30**, 3117 (1915).
[8] Kodicek, E., *Biochem. J.*, **34**, 724 (1940).
[9] Bovarnick, M. R., *J. Biol. Chem.*, **148**, 151; **149**, 301; **151**, 467 (1943); **153**, 1 (1944).
[10] Cleckley, H. M., Sydenstricker, V. D., and Geeslin, L. E., *J. Amer. Med. Assoc.*, **112**, 2107 (1939).
[11] Gottlieb, B., *Brit. Med. J.*, 392 (1944).
[12] Benesch, R., *Lancet*, i, 453 (1944).
[13] Evans, E. P., *Lancet*, i, 165 (1944).

## Production of a Soluble Pectinase in a Simple Medium by certain Plant-Pathogenic Bacteria belonging to the Genus Pseudomonas

IT has generally been assumed that plant-pathogenic bacteria are able to decompose pectin[1]. Thaysen and Bunker[2], however, limit themselves to the following statement: "to the aerobic pectin decomposers belong some of the many plant-pathogenic bacteria . . . In most of their biochemical reactions they resemble the *Pseudomonas fluorescens* group or those *Bacterium coli* forms which are regularly found in grass and hay". Although many plant pathogens do in fact belong to the genus Pseudomonas[3], including organisms responsible for soft rot[4] as well as necrotic lesions, yet no detailed study of the pectin-degrading powers of these green-fluorescent bacteria seems to have been made, nor has it been shown that they resemble the soft-rot organisms of the Bacterium group (for example, *B. carotovorum*) in producing an exo-cellular pectinase[5,6].

Pseudomonads have the simplest of growth requirements, and the pectin-ammonium salt medium devised by Coles[7], with one slight modification, is quite suitable for the demonstration of their pectin-degrading powers. The modification, following Waksman and Allen[8], lies in the substitution of pectic acid for pectin, partly for the reason that it is more easily recognized through its characteristic, gelatinous and insoluble calcium salt, and partly because only one enzyme, pectinase, instead of two, is concerned in its immediate breakdown. Waksman and Allen used a commercial polygalacturonic acid preparation as substrate. This material is not available here, but a suitable pectate medium can easily be prepared from B.D.H. citrus pectin in the following way: a 0·4 per cent solution of pectin in decinormal sodium hydroxide is left overnight at 20° in order that the methyl ester groups may be hydrolysed[9]. Sodium ammonium hydrogen phosphate (0·05 per cent) is then added and the medium brought to $pH$ 7·0[10] by the careful addition of $2N$ hydrochloric acid. Finally, after addition of potassium chloride (0·02 per cent), magnesium sulphate (0·02 per cent) and a trace of ferrous sulphate the medium is tubed and sterilized by steaming.

All the pseudomonads tested grew readily in this medium at 24°, even from a small inoculum, and could be maintained in serial cultivation in it without production of either acid or gas, the $pH$ remaining between 6·5 and 8. But good growth did not necessarily mean extensive degradation of soluble pectate, for out of thirty-five strains so tested, most of which were reputedly pathogenic and also fluorescent, only six actually degraded the pectic acid in a reasonable time. After three weeks incubation following a heavy inoculation, the metabolism solutions from these strains, after removal of bacteria by centrifuging, gave no appreciable precipitate with acetic acid and calcium acetate, whereas the metabolism solutions from the other strains still gave a copious gelatinous precipitate of calcium pectate. The six active strains were distributed as follows: *Ps. mors-prunorum* Wormald[11] (one out of eight strains); *Ps. syringæ* derived from pear (two out of eight); *Ps. marginalis*[4], *Ps. cerasi* and *Ps. tabaci* (one out of one in each instance). In addition to these six active and thirteen inactive strains the following

were also inactive: *Ps. prunicola* (two strains); *Ps. syringæ* derived from sources other than pear (three); *Ps. phaseolicola* (one); *B. tumefaciens* (two); *X. pruni* (one); ordinary saprophytic strains of *Ps. fluorescens* (seven).

Of the six active strains, three were outstanding, namely, *Ps. marginalis*, *Ps. cerasi* and one *Ps. syringæ* strain derived from pear, but *Ps. marginalis*, the only soft-rot organism tested, was the only strain which would grow from a small inoculum and simultaneously completely degrade all the pectate in the medium. Several strains of *Ps. mors-prunorum*, unlike the saprophytic strains, did, however, produce an appreciable degradation of pectate in thirty days when growing from a small inoculum. It would seem, therefore, that the soft-rot organism is more efficient in the degradation of pectate than even the more active of the strains responsible for necrotic lesions, which in turn are more active than any of the saprophytic strains here studied, all this being quite in accordance with legitimate expectation.

Each of the three active strains mentioned above produced an exo-cellular pectinase which could be precipitated by alcohol when all the pectate had been decomposed and the bacteria then removed by centrifuging. The simple medium here used, which contains no organic source of nitrogen, has obvious advantages over the complex media previously used in attempts to isolate soluble bacterial pectinase[5,12,13]. It is of interest that the Pseudomonas pectinase is active at $p$H 7–8, whereas mould pectinase acts best under much more acid conditions[8,14]. A further study of the bacterial enzyme is being made.

I wish to thank Mrs. D. H. Oxford, a special research officer of the Agricultural Research Council, lately affiliated to the East Malling Research Station, for most of the cultures used in the above study. Some were isolated by her and others by Drs. H. Wormald and H. B. S. Montgomery of the Station, to whom I also offer my thanks. The cultures of *Ps. marginalis*, *Ps. cerasi*, *Ps. tabaci* and *Ps. phaseolicola* were received from Dr. W. J. Dowson through Dr. Montgomery. It should be added that the generic names Bacterium, Pseudomonas and Xanthomonas are used in this communication in the sense advocated by Dowson in 1939[3].

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[1] Buchanan, R. E., and Fulmer, E. I., "Physiology and Biochemistry of Bacteria" (London, 1930), 3, 82, quoting Kruse, W., "Allgemeine Mikrobiologie" (Leipzig, 1910).
[2] Thaysen, A. C., and Bunker, H. J., "The Microbiology of Cellulose, Hemicelluloses, Pectin and Gums" (Oxford, 1927), 33.
[3] Dowson, W. J., *Zbl. Bakt.*, ii, **100**, 188 (1939).
[4] Dowson, W. J., *Ann. Appl. Biol.*, **28**, 102 (1941).
[5] Jones, L. R., *Zbl. Bakt.*, ii, **14**, 257 (1904).
[6] Norman, A. G., *Ann. Bot.*, **43**, 233 (1929).
[7] Coles, H. W., *Plant Physiol.*, **1**, 379 (1926).
[8] Waksman, S. A., and Allen, M. C., *J. Amer. Chem. Soc.*, **55**, 3408 (1933).
[9] Carré, M. H., and Haynes, D., *Biochem. J.*, **16**, 60 (1922).
[10] McFadden, D. B., Weaver, R. H., and Scherago, M., *J. Bact.*, **44**, 191 (1942).
[11] Wormald, H., *Trans. Brit. Mycol. Soc.*, **17**, 157 (1932).
[12] Werch, S. C., Jung, R. W., Day, A. A., Friedemann, T. E., and Ivy, A. C., *J. Inf. Dis.*, **70**, 231 (1942).
[13] Thornberry, H. H., *Phytopath.*, **28**, 202 (1938).
[14] Ehrlich, F., *Biochem. Z.*, **250**, 525 (1932).

## Reaction of Formaldehyde with Keratin

AN earlier communication[1] described the reaction of keratin fibres with boiling solutions of formaldehyde $p$H 2–10. For reasons connected with other work, buffer solutions one tenth the concentration described by Britton[2] were used, and since adequate buffering action could not be obtained at $p$H 1 under these conditions, no results were published for highly acid solutions of formaldehyde. The action upon keratin fibres of formaldehyde buffered to $p$H 1·0, 5·0 and 10·5 with full strength buffers is now described.

(1) *Normal Keratin.* Purified human hair fibres from the sample used in earlier experiments were boiled under reflux for 1 hour in solutions of 2 per cent formaldehyde $p$H 1·0, 5·0, 10·5. Full strength Walpole ($p$H 1·0, 5·0) and Ringer ($p$H 10·5) buffers were used[2], excess reagent being removed from the treated fibres by a 40 hours wash. The supercontraction of the fibres in boiling 5 per cent sodium metabisulphite was then measured in the standard way, three fibres being used for each $p$H value. Results, together with those for fibres boiled in buffer solutions alone, are given in Table 1.

TABLE 1.

| $p$H | 1·0 | 5·0 | 10·5 |
|---|---|---|---|
| % Supercontraction: | | | |
| Formaldehyde treated | 2·0 | 25·0 | 1·0 |
| Buffer treated | 25·0 | 21·0 | 1·0 |

Supercontraction of untreated hair = 26·0 ± 1·0 per cent.

It is obvious, therefore, that new linkages resistant to boiling metabisulphite were present in hair which had been boiled for 1 hour in 2 per cent formaldehyde at $p$H 1 or 10·5. The low supercontraction of fibres boiled in buffer solution at $p$H 10·5 is due to the presence of new linkages formed by secondary reactions of the sulphenic acid groups of hydrolysed disulphide linkages[1,3].

(2) *Deaminated Keratin.* Human hair fibres were completely deaminated in van Slyke's reagent[4]. The fibres were then treated with formaldehyde as in (1), except that in this case the reaction occurred in the presence of molar sodium sulphate. Table 2 gives the supercontractions of these fibres.

TABLE 2.

| $p$H | 1·0 | 5·0 | 10·5 |
|---|---|---|---|
| % Supercontraction: | | | |
| Formaldehyde treated | 15·0 | 33·0 | 5·0 |
| Buffer treated | 36·0 | 33·0 | Fibre destroyed |

Linkages resistant to boiling 5 per cent sodium metabisulphite, therefore, are formed in deaminated fibres on boiling in 2 per cent formaldehyde at $p$H 1 or 10·5.

The load/extension curves of fibres were determined[1] before and after deamination, and it was found that the reduction in the work required to stretch fibres 30 per cent of their original length was 31·0 ± 1·0 per cent. After standing overnight in distilled water, the fibres were boiled for 1 hour in 2 per cent formaldehyde at $p$H 1·0, 5·0, 10·5 in the presence of molar sodium sulphate, washed for 40 hours and then restretched. The further changes in work of formaldehyde and buffer treated fibres appear in Table 3.

TABLE 3.

| pH | 1·0 | 5·0 | 10·5 |
|---|---|---|---|
| % Change in work: | | | |
| Formaldehyde treated | +11·0 | +6·0 | −58·0 |
| Buffer treated | +1·0 | −1·0 | −61·0 |

On comparing these results with those in Table 2, it will be seen that no simple relationship exists between the effect of new linkage formation on the resistance of fibres to extension and on the supercontraction of fibres in boiling solutions of sodium metabisulphite.

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[1] Stoves, J. L., *Trans. Faraday Soc.*, 39, 294 (1943).
[2] Britton, H. T. S., "Hydrogen Ions", 217-223 (London, 1932).
[3] Stoves, J. L., *Trans. Faraday Soc.*, 38, 254 (1942).
[4] Speakman, J. B., *J. Soc. Dyers and Col.*, 50, 341 (1934).

## The Concept of Force

MR. JOSHUA C. GREGORY'S statement[1] "When a motor-car turns sharply round a corner the passenger feels as if he were shoved but not as if a thing shoved him" suggests that he has not clearly analysed the experience. The main sensations (other than visual) are of contact and pressure on the side of the body on the outside of the curve; in other words, of a force as ordinarily experienced acting towards the centre, in the same direction as the acceleration. The sensations are exactly similar to those felt in the back when a car accelerates rapidly. If there is no contact there is no sensation and no force, and the passenger continues in his previous uniform motion in accordance with Newton's First Law. In the same way, with high acceleration the head and shoulders which are not in contact with the back of the seat move relatively backwards over the top of this and experience no sensation of force.

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[1] *Nature*, 154, 24 (1944).

MR. JOSHUA C. GREGORY'S letter under this title[1] seems to me misleading. A "notion of force" without a "notion of matter" appears to me a contradiction. Without matter there can be no motion and therefore no acceleration; and without acceleration there can be no force since force denotes a mass-acceleration product.

When I go round a sharp corner in a motor-car I definitely experience the sensation of being shoved by the seat.

To describe forces as "immortal" or "imperceptible" strikes me as idealist nonsense. A force lasts just as long as the matter with which it is associated has acceleration; the force associated with the retardation of a hammer on one's thumb is perceptible enough. "Disembodied force" is as meaningless as "matterless motion". Let us keep these anthropomorphic and idealist notions of force out of physics; force would exist in a lifeless universe.

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S. Devon.

[1] *Nature*, 154, 24 (1944).

THE description of force, gathered from the "Hermetica" into my communication in *Nature* of July 1, p. 24, does not, as such, ask Mr. John Case to believe in "immortal" and "imperceptible" forces, or to adopt any "anthropomorphic and idealist notions". In 1864 Colding connected immaterial and imperishable forces with the perpetuity of energy which had been clear to him since 1840, and there is at least a hint at the modern conservation of energy in the immortal forces of the "Hermetica". Those who still refuse to reduce causal *efficacies* to mere regular routine can sympathize with the *working* of the Hermetical forces. The letter, however, only suggests that the Hermetical concept of force embodies a recognizable distinction in sensory experience. The concept can do this however violently modern thought disclaims it in other respects.

Muscular sensations themselves, the suggestion runs, only produce a sense of what Prof. Price calls "pure force, disembodied force as it were". This corresponds to the incorporeal nature of the Hermetical force. Sensations of contact are essential to complete the sense of the resistant or propulsive material thing. The Hermetical forces only work in bodies; this corresponds to the very usual combination of muscular and contact sensations. Cut out a man's contact sensations, leave all his other sensations in, he will then, according to the suggestion, have only a sense of "disembodied force" and have no sense of material things. If this sense of pure or disembodied force is actually felt in the centrifugal experience, as Price suggests, the phrase "disembodied force" is not "meaningless", as Mr. Case asserts.

Mr. W. B. Yapp concentrates on a denial of this sense of pure force when a motor-car corners rapidly or accelerates sharply. When a motor-car turns quickly, a passenger on the back seat is thrown somewhat laterally and *feels*, or may feel, as if an immaterial force throws him, as if he is shoved without being shoved by a material shover. This is the experience of the writer and presumably of Prof. Price. Some people stress unexpectedness—they have this sense of pure force when the car takes them unawares as it corners quickly. They have a similar experience during a sharp acceleration backwards or forwards. There seem also to be analogous aeroplane experiences. When I am 'centrifuged' in a motor-car I do not "definitely experience the sensation of being shoved by the seat", as Mr. Case does, nor do I sense a contact push on my free side when I am pressed against the resistant side of the car, as Mr. Yapp seems to do.

Some people at least confess to a momentary feeling of "what on earth is happening!" and an evanescent whiff of uncanniness sometimes rushes through me. Mr. Case and Mr. Yapp may dissent because the inveterate tendency to connect pushes or pulls with contacts predisposes them against a recognition of the actual, though usually momentary, experience. Many 'centrifuged' passengers do seem to glimpse, if only for a moment, the sense of disembodied forces that might be habitual if there were no contact sensations. The experience seems to occur, however the somewhat elusive concept of force is finally assessed.

Prof. Price, of course, though he gave me a cue, is not responsible for the use made of it.

JOSHUA C. GREGORY.

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Leeds, 2.

## Fatigue in Selenium Rectifier Cells

THE effect described by Mr. J. S. Preston in his letter in *Nature* of June 3[1] may be connected with the increased departure from linearity of response which Dr. W. R. G. Atkins and I[2] found to occur in a number of these cells when illuminated by light of wave-length greater than about 0·66 μ. We were interested in the use of these cells to measure daylight, especially under water, where very large changes of illumination occur and optical methods of varying the exposure of the cell are very inconvenient. Long range and large maximum illumination were therefore essential, and the photometer bench used gave a range of 1 to 725. A filament lamp behind a water cell 4·4 cm. thick gave a maximum illumination estimated at some 15,000 lux when no colour filter was used. Schott *BG* 12, *RG* 1 and *RG* 5, Corning Green and Zeiss 966/8 filters, singly or combined, enabled different spectral regions to be tested. Fatigue effects were reduced to the utmost by keeping the cell in the dark except for the few seconds needed to balance the Campbell-Freeth circuit by which the current was measured. The comparative steadiness of the balance seemed to show that in this case fatigue was unimportant. We did not notice enhanced fatigue in red light, possibly because we expected a small fatigue effect due to the warming of the cell circuit by the comparatively intense deep red and near infra-red radiation transmitted by the red filters.

Under these conditions we found that for a Weston cell and light of wave-length below about 0·66 μ, the sensitivity, as measured by the Campbell-Freeth zero resistance circuit, was nearly constant up to about 100 μamp., showing, in fact, a small rise with current up to a few microamperes, as found for some cells by other workers. For wave-lengths above 0·66 μ, however, the sensitivity commenced to fall at about 1 μamp., and had fallen by 15 per cent at 100 μamp. Another Weston cell showed a similar effect, and eight electro cells each showed it to an enhanced degree.

Adding to the resistance of the circuit of course increases the departure from linearity, but we were somewhat surprised to find that for each cell tested the inclusion of 1,000 ohms in the circuit produced a fall in current depending only on the initial current, and not at all on the colour of the light to which it was due. We accordingly suggested that the red light effect was of a primary nature, and due to the existence in the selenium cells of a photo-electric threshold near 0·66 μ, causing a tendency to saturation in the current produced by intense illumination of longer wave-lengths.

The increase in the transparency of selenium near 0·64 μ may be connected with a reduction in the number of photo-sensitive and hence light-absorbing electrons as we passed through that spectral limit. This limit, as found by Mr. Preston for the fatigue effects, is so close to our approximate limit for the curvature effect that it seems probable that the two effects are closely connected.

H. H. POOLE.

Royal Dublin Society. June 16.

[1] *Nature*, 153, 680 (1944).

[2] *Sci. Proc. Roy. Dub. Soc.*, 22, 393 (1941).

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THE results to which Dr. Poole refers seem certainly to be related to the fatigue effects which we have noticed. During a recent visit to this Laboratory, Dr. Atkins directed our attention to these results and we discussed them in some detail.

Taken in conjunction with our own, they point to a close correlation between various properties of the cells, as Dr. Poole suggests, and there now seems good reason to believe that the basic common factor is the existence of a photo-electric, and an associated transparency, threshold in the neighbourhood of 0·66 μ or 0·64 μ. The way in which this factor enters into the action of the cell is certainly of practical interest and may be of fundamental importance. Our suggestion that the comparatively deep penetration of red light into the selenium results in a kind of space-charge retarding the emission of electrons from the deeper layers is, of course, only tentative; but such a mechanism would provide for both the non-linearity and the fatigue effects together, provided the space-charge is not built up instantaneously. This supposition recalls also the kind of fatigue exhibited by the older resistance type of cell.

The subject of fatigue merits careful investigation and we hope to carry out further work upon it.

J. S. PRESTON.

Light Division, National Physical Laboratory. July 4.

## Relation between Dissonance and Context

IN an attempt to meet some of the criticisms made of our previous work on the effect of musical context on dissonance[1] a new experiment has been carried out.

A single 'dissonant' chord, the seventh on the sub-dominant (when in *C* Major), second inversion ($c_0\ a_0\ f'\ e''$, according to the tone nomenclature given by Myers[2]), was used throughout as the chord to be investigated, and will be called the 'test chord'. Mr. C. G. Gray suggested this chord, and offered several contexts for it. A number of other passages in which it appeared were found in well-known works, with an additional passage composed by Mr. Gray and slightly altered by the writers. Altogether there were fourteen passages: two by Chopin, one by Weinberger, nine by Greig, one from a traditional air and one by Mr. Gray. The test chord, though, of course, it was not always in *C* Major, did always consist of the same four identical notes.

The passages were played on the piano to fifty students (43 women and 7 men). The aim of the experiment was explained beforehand, and the subjects were asked to avoid judgments of liking and disliking and to concentrate upon consonance and dissonance. As each passage was played by one of the experimenters (P. A. D. G.), the other (R. W. P.) raised his hand when the test chord was sounded and then immediately lowered it again. Each passage was played over in this way often enough for all the subjects to be satisfied that they had identified the test chord and rated it on a scale +3, +2, +1, 0, −1, −2, −3, from very consonant to very dissonant.

The subjects had all received instruction in the psychology of sound and had done the Oregon and other music tests. They also filled in a questionnaire on degree of musical interest. Their average score for on the Oregon test was 77/96, and the scores of this test correlated +0·576 ($p<0·01$) with the questionnaire results converted into a quantitative form. These points show that the musical ability of the group was high. The subjects were astonished

when told afterwards that they had rated the same chord throughout.

The ratings of the test chord were tabulated and their frequencies are shown in the accompanying table:

| Rating | +3 | +2 | +1 | 0 | −1 | −2 | −3 |
|---|---|---|---|---|---|---|---|
| Frequency | 62 | 119 | 101 | 52 | 164 | 124 | 78 |

This distribution of frequencies is quite incompatible with the possible hypothesis that the test chord was of constant or even of approximately constant dissonance-level. They are significantly different from a purely chance distribution of the total of 720 ratings into the seven classes, and show that the chord was most often considered moderately dissonant.

Analysis of variance of the table of ratings showed that the variance due to differences between contexts outweighed the error variance by an amount of which the probability was less than 1 in 1,000. This result is very strong evidence that the dissonance-level of the test chord varied with its musical setting. The variance due to differences between individual subjects was significantly greater than the error variance, and significantly lower than the variance due to differences between contexts. This is evidence that the musical standards, opinions or preferences of the subjects were factors in determining dissonance level, but of far less importance than the effects of varying the musical context.

It may be suggested that 'dissonance-level' is a *Gestalt* phenomenon. It is determined by several factors, of which the chief are (*a*) the physical composition of the chord, (*b*) the 'schemata' in our minds which arise from experience and depend on musical ability, on training and on tradition, and (*c*) the musical effect, import or intention of the passage as a whole. The latter was the outstanding influence in this experiment, and it has been dealt with in a letter to us by Mr. John L. Dunk. This is too long for quotation, but in it he has given passages from Beethoven, Elgar and Wagner, showing that sometimes a chord 'theoretically' correct may be excessively harsh in relation to the musical import of the context; whereas in other passages a dissonance which could scarcely be defended in theory, at least at the period when it was composed, may be completely appropriate from the point of view of the import of the passage as a whole.

We are indebted to Mr. Joseph F. Simpson for his help with the calculations.

P. A. D. GARDNER.
R. W. PICKFORD.

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University, Glasgow.

[1] *Nature*, **152**, 358 (1943); **152**, 570 (1943); **153**, 85 (1944).
[2] Myers, C. S., "Experimental Psychology", Part I, 26–27.

## Science and the Fisheries

IN his admirable discourse at the Royal Institution[1] Michael Graham declares with good reason that "the Great Law of Fishing is that unlimited fisheries become unprofitable", and he deduces that "the only adequate measure to conserve the fishery is to set some limit to the amount of fishing". Fishery legislation, with its restrictions upon fishing areas, upon the mesh of nets, upon the size of fish landed and so on, has not succeeded in staying the downward drift, and more restriction is necessary. The Great Law of fishery legislation, based upon sound scientific advice as things stand, is restriction.

Now an outstanding lesson of the United States contribution to the International Fisheries Exhibition of 1883 and its Conferences, to which Graham refers, was, so far at any rate as freshwater fisheries are concerned, the reverse of restriction. The United States Fish Commission realized that "were the governmental policy directed towards preventing the people from catching the few [fishes] left after generations of improvidence, the expense would be enormous, while such laws would be evaded constantly, and almost with impunity"[2]. The Commission therefore dropped a negative for a positive policy and decided "to expend a comparatively small amount of the public money in making fish so abundant in the rivers and lakes that the public itself may fully and freely enjoy the result"[2]. That was the ideal.

May we not look to the same sort of positive policy in regard to sea fisheries, instead of accepting as axiomatic that restriction of fishing is the only adequate means of keeping up the fish population? Scientific workers know enough about the fundamental relations between the chemistry and physics of the sea and the organisms that live in it to attempt some control of these for the benefit of the fisheries. On a small scale the success of such control, by the addition of chemical nutrients, has been indicated by the work on oyster culture in Norway, and by the limited and still incomplete but developing experiments of Dr. Gross and his colleagues in Loch Sween in Argyllshire. In fresh waters, where the basic problem is similar, I am told by the chief of the Biology Division of the United States Department of Agriculture, Edward H. Graham, that it has been encouraging farmers to add chemical nutrients to ponds for the purpose of increasing growth of selected species of fishes, and thus increasing the war-time supply of food.

If the Loch Sween experiments in their wider range are successful, they will point to the possibility of improving sea fisheries instead of curtailing them. If they are not successful, other experiments with the same end in view should be considered. My plea is that scientific workers in fishery matters should turn more attention to the progressive and productive, rather than to the restrictive, possibilities. There is one important point, however, which must be borne in mind. In his paper on the fishery industries of the United States, read at the Conference associated with the International Fisheries Exhibition of 1883, Prof. G. Brown Goode pointed out that "public fish culture is only useful when conducted upon a gigantic scale—its statistical tables must be footed up in tens of millions" [of fishes, not dollars]. In the sea the scale must be vastly greater, it must be international; so that we may be allowed to speculate upon a day, perhaps not many years hence, when the International Fisheries Commission of the nations bordering the North Sea may discuss, along with its programme of researches, the allocation of the sums to be contributed by each nation for chemical nutrients, in the assurance that these will support a larger fish population and an increased fishing fleet in the North Sea.

JAMES RITCHIE.

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Aug. 1.

[1] *Nature*, **154**, 105 (1944).
[2] Whymper, F., in "The Fisheries of the World: an illustrated and descriptive Record of the International Fisheries Exhibition of 1883 [1884]", 251.

# RESEARCH ITEMS

## Inheritance of Tuberculosis

IT has been difficult in the past to evaluate correctly the evidence for the inheritance of tuberculosis or of tendencies which might facilitate infection. Obviously twins provide material which might give valuable evidence on this matter. The analysis of twins has been developed by F. J. Kallmann and D. Reisner (*J. Hered.*, 34, 293; 1943), with highly significant results. 616 twins, 930 sibs, 74 half-sibs and 668 parents in 308 complete families containing twins have been statistically analysed regarding the incidence of tuberculosis. The chance of contracting the disease increases in strict proportion to the degree of consanguinity to a tuberculous patient. The fact that monozygous twins exhibit 16 times as much similarity in resistance as compared with dizygous twins when all criteria are considered indicates that heredity, probably of a multifactorial nature, influences resistance. The authors point out that resistance to the invasion of the bacillus may be different from the factors of resistance to the spread of the established disease. This is supported by the fact that while there is a difference of 1 : 16 between resistance to progressive disease, there is only a difference of 1 : 3·5 in resistance to any form of clinical tuberculosis in monozygous and dizygous twins. The authors are proceeding further with this important analysis.

## Freshwater Bryozoa

MARY D. ROGICK, in her "Studies of Fresh-water Bryozoa. XIV. The Occurrence of *Stolella indica* in North America" (*Ann. New York Acad. Sci.*, **45**; 1943), records *Stolella indica* Annandale from North America for the first time. The genus was known hitherto only from Asia and South America. This freshwater bryozoon was collected in a pond in Westtown, Chester County, Pennsylvania, where it was fairly abundant on submerged twigs. The pond is fed from a spring passing through a meadow and contains much submerged pond-weed and some lily pads. Filamentous algæ were abundant on the submerged twigs, logs and other objects. In a larger pond nearby, four other species of freshwater Bryozoa occurred. A note on statoblasts in general suggests a simplification in nomenclature, and the terms floatoblasts, sessoblasts and spinoblasts are used for floating, sessile and spiny statoblasts respectively.

## Biotin Content of Enzymes

AMONG the members of the vitamin B complex, thiamin, riboflavin, and nicotinic acid occur in combination with a protein, that is, as the prosthetic groups of enzymes involved in respiration. The other members have been assigned no definite role in cellular metabolism. Several of these, notably biotin and *para*-aminobenzoic acid, occur in tissue in a bound form and are liberated only on strong hydrolysis. It might be expected that they also function as prosthetic groups of enzymes. D. R. Miller, J. O. Lampen and W. H. Peterson (*J. Amer. Chem. Soc.*, 65, 2369; 1943) find, however, that the biotin and *para*-aminobenzoic acid contents of six crystalline and three non-crystalline enzyme preparations, and one crystalline protein not an enzyme, lead to minimum molecular weights far in excess of the figures assigned to these enzymes. It is assumed, therefore, that the biotin and the acid are more probably contained as impurities in the crystalline proteins rather than forming an integral part of the enzyme.

## Physiology of Pollen

D. LEWIS (*J. Genetics*, 45, 117 and 261; 1943–44) has published further results of his work on the physiology of pollen, which is having far-reaching scientific as well as practical results. He shows that autotetraploidy weakens the inhibition of incompatible pollen. By suitable crosses in synthetic polyploids of *Oenothera organensis*, he has shown that the reduction of the inhibition is due solely to the diploidy of the pollen and not to the tetraploidy of the style. Pollen grains with two different *S* allelomorphs have been used on styles with one or both genes. In some cases there was a difference in compatibility, in others the result was indifferent. These results are considered in relation to the hypothesis that the *S* allelomorphs are competing for an antigenic substance similar to the antigen-antibody reaction in animals. Among many details of importance the author indicates that the effect of one *S* allelomorph of one pollen grain may sometimes be influenced by an association with another *S* allelomorph before pollen-grain formation. In the second paper, the author shows how the discovery of the weakened inhibition to diploid pollen may be used in the production of useful polyploid economic plants. By treating the pollen-mother cells with heat shocks, pollen grains with the unreduced number of chromosomes may be produced. If these pollen grains are heterozygous for the *S* allelomorphs, they will function on a diploid style, whereas the haploid pollen grain will be inhibited by the normal incompatible mechanism. By this method, triploid pears have been produced, and results in plums, cherries and apples indicate that much use should be made of Lewis's method in the future.

## Inheritance of Tristyly in *Lythrum Salicaria*

THE historic work of C. Darwin and Lady Barlow upon the inheritance of long-, mid- and short-styled plants of the loosestrife raised several unsolved problems. East published a hypothesis of lethal mid-genes to attempt to explain the results of crossing. This hypothesis left a number of unaccounted exceptions. R. A. Fisher and K. Mather (*Ann. Eugenics*, 12, 1; 1943) have followed their letter in *Nature* (150, 430; 1942) on this subject with extended results. They show that East's theory that the mid-gene was lethal when homozygous is wrong. By special methods of open pollination and statistics they have analysed large progenies and infer that the inheritance of long, mid and short is polysomic in type. Whether the inheritance is tetrasomic or hexasomic is unknown, but experiments are in progress. The authors have grown an open-pollinated population at Chelsea Physic Garden, and find that the mids have reduced fertility both in seed and pollen. This is different from that discovered by Darwin, and they suggest, therefore, that the experiment might be repeated at Down House, where the original work was performed.

## Iron Hill Igneous Complex, Colorado

THE detailed report by E. S. Larsen on the rocks and minerals of the Iron Hill stock in south-west Colorado (*U.S. Geol. Surv., Prof. Paper* 197 A; 1942) is an important and long-awaited contribution to descriptive petrology. The stock has an area of

twelve square miles; it is emplaced in Pre-Cambrian granites and is overlain by late Jurassic sandstones. The sequence of rocks in the complex is as follows: (*a*) A mass of dolomitic marble which forms an isolated hill a mile across, as well as several small inclusions within the later rocks. From the evidence of bodies of similar marble in the neighbourhood it is believed that the main mass is of hydrothermal origin, though it may have been intruded as a carbonate magma. (*b*) A coarse-grained melilite rock known as uncompahgrite. (*c*) A pyroxenitic suite which makes up about 70 per cent of the area and ranges from diopside-rock to types composed of biotite, perovskite-magnetite and apatite-perovskite, with varieties containing felspar, nepheline and sphene. (*d*) Ijolite composed of pyroxene, garnet and nepheline. In places nepheline appears to have 'soaked' into the pyroxenites. (*e*) Soda-syenite, commonly banded and associated with (*f*) a later nepheline-syenite; both (*e*) and (*f*) tend to occur near the borders of the stock. (*g*) A series of dykes of either nepheline-gabbro or quartz-gabbro, or in some cases both. Hydrothermal solutions were active throughout the history of the stock. To explain the origin of the complex the author postulates crystal differentiation of a basaltic magma modified by assimilation of marble in depth, but he himself points out one serious weakness in this conventional hypothesis, namely, its failure to account for the very high $TiO_2$ and $P_2O_5$ which characterize most of the rocks.

### Magnetic Susceptibility of Iron Tetracarbonyl

IRON tetracarbonyl, which has a molecular weight roughly corresponding with the formula $[Fe(CO)_4]_3$ is, like the other metal carbonyls, diamagnetic. The susceptibility values reported vary rather widely, and the value has been redetermined by H. G. Cutforth and P. W. Selwood (*J. Amer. Chem. Soc.*, 65, 2414; 1943). A well-crystallized material was prepared by way of the carbonyl $Fe_2(CO)_9$ from $Fe(CO)_5$. The actual material was found to be paramagnetic, suggesting para- or ferro-magnetic impurities. Measurements over a range of field strength showed that the susceptibility depended on the field. By plotting susceptibility against the reciprocal of field strength, extrapolating to infinite field strength gave a susceptibility of $-0{\cdot}07 \times 10^{-6}$, which is of the order expected, though rather small.

### Electric Arc between Solid Carbons and Graphite Electrodes

IN a paper by J. T. MacGregor-Morris (*J. Inst. Elec. Eng.*, 91, Pt. 1, No. 41; May 1944) entitled "Experiments on the Candle-Power and Brightness of the Positive Crater of the Electric Arc, using Solid Carbons and Graphite Electrodes", a critical examination is made of the ways in which a standard of high-intensity light could be developed using the positive crater of an electric arc between carbon electrodes in air, and an account is given of much hitherto unpublished experimental work bearing on this problem. A three-electrode arc was adopted in the researches, and a physical photometer was used in which a galvanometer deflexion automatically gave a measure of the light output of the arc. The accuracy of the method exceeds that possible with visual photometry, and rapid variations of candle-power can be observed. Graphite electrodes and a wide range of uncored soot electrodes were used. For a standard, either the candle-power of the positive crater measured along the axis of the anode might be used, or the brightness of a small portion of the crater near the centre. Measurements are given of the effect on candle-power and brightness of many factors including diameter, resistivity and purity of the anode, arc current, negative electrodes, atmospheric pressure and absorption due to arc flame. Special attention is given to the elimination of a phenomenon the existence of which is generally not obvious, namely, the rapid rotation of the arc stream, which is accompanied by a reduction of candle-power and brightness of uncertain amount. A critical comparison is made with other published work, especially work in other countries, and it is concluded that a standard can best be developed utilizing brightness, an accuracy of 1 per cent being so far attained.

### The Starch-Iodine Complex

THE nature of the blue material formed by the action of iodine on starch has been much discussed. In a series of papers by R. E. Rundle and co-workers (*J. Amer. Chem. Soc.*, 65, 554, 558, 1707, 2200; 1943; 66, 111, 130; 1944) evidence is presented for the view that the starch molecules are helical chains with a helix diameter of about 13·7 A., a length per turn of about 8 A., and about six glucose residues per turn, and in the starch-iodine complex the iodine molecules occupy the interior of the helices. Absorption spectra are said to confirm the existence of amylose and amylopectin as two components in whole starch. The amount of iodine bound in complex formation with amylose increases as the concentration of iodide decreases, becoming one iodine molecule for six glucose residues for infinitely dilute iodide solutions.

### New Methods in Stellar Dynamics

S. CHANDRASEKHAR (*Ann. New York Acad. Sci.*, 45, Art. 3, 131; 1943) has prepared an abridged version of new methods developed by him for the investigation of the dynamics of stellar systems. An outline of the general principles of a statistical theory of stellar dynamics is provided in the paper. An interesting point is mentioned in dealing with the statistics of a gravitational field which arises from a random distribution of stars. The acceleration which a star suffers during a certain interval can be formally expressed as the sum of two terms: (1) a systematic term due to the action of the gravitational field of the smoothed out distribution; (2) a stochastic term representing the influence of the near neighbours. There is a similarity between the problem presented by stellar dynamics, as stated in the above fashion, and the problems which occur in the modern theories of Brownian motion. Part 3 of the paper deals with the rate of escape of stars from clusters and the evidence for the operation of dynamical friction; the Pleiades cluster is considered in relation to the results obtained. When dynamical friction is ignored, a half-life for the Pleiades of $5 \times 10^7$ years is predicted; but if it is taken into consideration, the half-life is $3 \times 10^9$ years, and there is little doubt but that dynamical friction provides the principal mechanism for the continued existence of the galactic clusters like the Pleiades for times of the order $3 \times 10^9$ years. Allowing for dynamical friction, however, will not account for half-lives of the order $10^{10}$ years for such clusters, and this provides support for the now currently adopted 'short time-scale' of the order $3 \times 10^9$ years.

# APPLICATIONS OF SPECTROSCOPY

A CONFERENCE on the applications of spectroscopy to industrial and other problems was held, under the auspices of the London and Home Counties Branch of the Institute of Physics, at the Imperial College of Science and Technology on July 1; Dr. S. Whitehead presided.

The introductory address was given by Prof. H. Dingle, of the Imperial College, who opened with a short historical account of the development of spectroscopy. The pioneer work of Newton and, later, Fraunhofer, found no immediate practical application, and it was not until the middle of the nineteenth century that the subject began to acquire a general significance. Under the name of spectrum analysis, it was then regarded as a department of chemistry, and its discovery of new elements, coupled with the realization that a new and rapid method of chemical analysis had become possible, aroused hopes that a process of great practical value had been brought to light. These hopes were quenched, however, by the apparent capriciousness of the method, arising from causes which, in the existing state of physical and chemical knowledge, it was impossible to understand, and chemists soon abandoned it almost entirely. For the next few decades spectroscopy was kept alive, and in some degree developed, by astronomers, for whom no other means of astrophysical investigation was available, and in spite of some unavoidable errors, their contribution was an essential preliminary to the great revival which came with Bohr's theory of the hydrogen atom in 1913. For some dozen years thereafter, spectroscopy stood in the forefront of atomic physics, and the picture of the outer structure of atoms which eventually emerged was constructed *pari passu* with the explanation of the successive details of spectra.

This work, so far as atoms are concerned, is now almost complete, and one of its consequences is the rebirth of *applied* spectroscopy. Two main causes have been responsible for this. First, the requirements of physicists, in their enthusiasm to penetrate the secrets of atomic structure, impelled scientific instrument makers to turn their attention to the mass production of spectrographic apparatus, and this is now available in large quantity. Secondly, the newly acquired knowledge of the processes of production of spectra has made it possible to understand the vagaries which alienated the interest of earlier workers, and the spectrum has become a safe index to both the chemical composition and physical condition of the source of light. Prof. Dingle stated that the problem of qualitative spectrum analysis can now be regarded as solved; but considerable experience—not always possessed by the authors of published analyses—is necessary for trustworthy results. No general process of quantitative spectrum analysis, however, has so far been devised, although in certain special problems the method has been successfully used. He presented an analysis showing the various factors contributing to the strength of a photographed spectrum line, and described work which has been done at the Imperial College—and will be resumed as soon as conditions allow—directed towards the control of all of them except the amount of the corresponding element in the mixture to be analysed. The work of Mr. E. W. Foster, already published*, will, it is hoped, provide a basis for a process of quantitative spectrum analysis of great generality.

* *Proc. Phys. Soc.*, **53**, 594 (1941).

Mr. F. Twyman, managing director of Messrs. Adam Hilger, Ltd., followed with a description of certain spectroscopic instruments now available. He confined his remarks chiefly to those which seem of most immediate importance—namely, instruments for analysis by emission spectra and those for identification and estimation of liquids or vapours by absorption in the visible, ultra-violet and infra-red regions. The number of spectrographic analyses of minerals and alloys in Great Britain alone must run into millions every year, while absorption spectra, particularly in the infra-red, have lately assumed great importance in problems of molecular structure of interest to the biochemist and the industrial chemist. The commonest instrument for the production of emission spectra is still the quartz spectrograph; but gratings, largely through the advocacy of G. R. Harrison in America, have recently come into more general use, and experience must decide which is to be preferred for practical purposes. In quantitative work an estimate of the strength of spectrum lines must be made, and for this purpose microphotometers, or micro-densitometers, are available. Attempts have been made to measure intensities directly by photo-electric cells, but there is little doubt that for a long time to come the spectrum will be recorded photographically and the strength of the lines measured by the blackening of the plate. Mr. Twyman next discussed improvements in sparking circuits, and concluded his remarks on instruments for emission spectra by a brief reference to the identification of chemical compounds by X-ray crystal analysis.

The most characteristic feature of apparatus for absorption spectra in the visible and ultra-violet regions is the photometric device, of which the first example was the sector spectro-photometer. The principle of this instrument is common to all subsequent photographic spectro-photometers, except very recent ones still in the experimental stage; but certain improvements in detail have been introduced, which are exemplified in the Spekker photo-electric absorptiometer. In the infra-red, where absorption spectra give important information bearing on the structure of organic molecules, the original Hilger instrument designed in 1909 is, with a few improvements, still in use to-day. Prisms of quartz, fluorite, rock-salt and sylvine are available, making investigation of the infra-red region possible up to at least 21 $\mu$. The radiation is detected by a thermopile, and a recording form of the instrument has been devised.

The next speaker was Mr. D. M. Smith, of the Research Department of the British Non-Ferrous Metals Research Association. He discussed chiefly the difficulties met with in the spectrographic analysis of non-ferrous metals and alloys. In this work the chief problem is the quantitative determination of traces of impurities, and the methods adopted usually involve microphotometric measurements of arc and spark spectrograms, especially the latter. Important sources of error lie in the lack of precise specification of sparking conditions, lack of complete understanding of the effect of small differences between the samples to be analysed and those used to provide standards for comparison, and uncertainties in plate calibration arising from imperfect design in certain types of microphotometer. The British Non-Ferrous Metals Research Association has for some time been collaborating with its members in attempting to improve the accuracy of spectrographic methods, four panels of the Research Sub-Committee having been formed.

In addition to reports from the Photographic, Aluminium and Lead panels (the fourth panel deals with problems common to all the methods), further papers on specific applications are shortly to be published in book form under the title "Collected Papers on Metallurgical Analysis by the Spectrograph".

It is generally agreed that the standard alloys used for comparison should be closely similar in bulk composition and metallurgical history to the samples for analysis, and some pre-sparking is generally regarded as desirable in non-ferrous analysis, although in the analysis of steels it appears to be unnecessary. The 'direct comparison' method, due to A. Walsh, in which no internal standards are used, has proved successful in certain problems, but it is very susceptible to errors from incomplete control of the spark discharge. The reproducibility of spectrographic determinations is most concisely expressed by the standard deviation derived from an adequate number of repeat tests on the same sample, although the calibration of the plate by the use of standard alloys is a possible source of systematic error. In general, methods of compensation, based either on empirical relationships or on considerations of source temperature, are less satisfactory than improvements in the source of excitation as regards increasing analytical accuracy.

Dr. W. A. Roach, of the East Malling Research Station, then addressed the Conference on applications of spectroscopy to biological problems. Lundegardh (1928) and Ramage (1929), he said, were two of the earliest workers to use emission spectroscopy for studying the biological importance of minerals. Ramage burnt the dried and powdered material, rolled in a filter paper, in front of the slit of a spectrograph. Lundegardh sprayed a solution of the ash into an oxy-coal gas flame. The arc method has been used by Webb and Fearon (1937) to make a survey of elements occurring in living tissues, and by Lewis, who found that serious trouble in young animals on 'teart' pastures in the west of England was caused by an excess of molybdenum. Mitchell used Goldschmidt's cathode layer method of soil analysis for studying a serious trouble in sheep called 'pining', which was traced to a deficiency of cobalt. These and absorptiometer methods are now in routine use in a number of biological laboratories.

Similar methods, as well as others, are being used at the East Malling Research Station for the diagnosis of mineral deficiencies and excesses in plants. The limitations of plant analysis when employed alone are illustrated by facts first discovered by Passy (1910) when seeking the cause of widespread chlorosis (absence of chlorophyll) in an orchard. The trouble was cured by injecting an iron salt into the chlorotic trees; yet the percentage content of iron was highest in chlorotic foliage, lower in certain green branches and trees found in the orchard, and lowest in the trees injected with iron salt. The iron in the chlorotic leaves must have been in a form useless to the plant. When iron in a useful form was injected, the leaves grew in proportion to the injected iron, which 'diluted' the useless iron obtained naturally. This type of faulty mineral uptake is known as 'lime-induced chlorosis', since it is common on soils containing excess of calcium carbonate.

A system of diagnosis is being built up by studying the mineral composition of plants in relation to their performance, supplemented when necessary by testing how far performance is improved by injecting more of any selected element into the plant. Healthy plants tend to have a characteristic composition, and a deficiency of any essential element can be diagnosed by analysis alone. When calcium occurs in excess, however, the normal content of any of the trace elements (iron, manganese, zinc, boron, copper, etc.) may prove inadequate because it may be in a state useless to the plant. Supplementary methods, such as plant injection and a study of plant symptoms which are often characteristic of mineral deficiencies, must then be employed.

The final address was given by Dr. R. W. B. Pearse, of the Imperial College, who spoke on applications of the band spectra of molecules. These fall into two classes: first, those in which direct use is made of the spectrum, and secondly, those in which the spectrum is analysed in order to determine the structure of the corresponding molecule. In applications of the first class, a band system, and not an individual band, is to be taken as the molecular analogue of a single line in the spectrum of an atom. By means of such systems the scope of analysis can be extended in several ways. Thus, inaccessible sources of light, such as comets for example, sometimes show the presence of many of their constituents by bands and not lines. Secondly, certain elements which give no line spectra in the ordinary regions of observation when subjected to arc or spark conditions readily show bands if suitable elements are present with which they can combine. Thus, fluorine and chlorine can often be detected by bands of $CaF$ and $CuCl$; nitrogen and oxygen in the atmosphere of a copper arc show a spectrum of $NO$; and the spectrum of a hydrogen flame shows $S_2$ bands when sulphur is present. Thirdly, glow discharges in vacuum tubes often show bands which indicate the nature and purity of the gases present, and give a clue to the origin of unwanted residual gases, for example, leakage from the air, presence of moisture, degassing of walls, decomposition of grease, etc. Fourthly, absorption spectra have enabled certain complex molecules to be identified, and indicated changes in the constitution of such molecules by corresponding changes in the spectrum. Tables of data are now available for the identification of molecular spectra, and their use could be greatly extended.

Applications of the second class require a much more detailed study of the spectrum. The spectra of diatomic molecules can be analysed into bands and branches, and energy-level diagrams constructed. Molecular constants representing the levels give the separation of the constituent atoms, the moment of inertia of the molecule, its frequency of vibration and electronic energy in various states, and the law of force between the atoms. If the observations are sufficiently extensive, the energies of dissociation for the various states can be obtained. This knowledge can be used, with the co-operation of the mathematician and the physical chemist, to throw light on many chemical problems. The determination of temperature and detection of isotopes are further possible products of the analysis of molecular spectra.

A short discussion was held at the conclusion of the meeting, at which it was proposed by Dr. J. Convey, and seconded by Dr. H. Lowery, that in view of the great importance which applied spectroscopy has acquired in various fields, the Board of the Institute of Physics should be asked to arrange for the formation of a group for the study of the subject. The proposal met with general agreement, and is to be submitted to the Board.

# CONTROL OF CROSS-INFECTION BY BACTERIA

THE Medical Research Council's War Memorandum, No. 11, entitled "The Control of Cross-Infection in Hospitals" (London: H.M. Stationery Office, 1944. 6*d*. net) epitomizes a great deal of research on this important question. Cross-infection, says Sir Wilson Jameson in his introduction, is most apparent and dangerous among infantile and juvenile patients in hospitals, so that this memorandum deals mainly with the risks in children's wards; but it is pointed out that the risks exist also among children at home and wherever else they assemble. Nor are adults by any means free from them. The risks are naturally greatest where infectious diseases are being treated, but they exist in every hospital ward; and, when a cross-infection occurs, the cost of it may be so high that any measures taken to prevent it are in the long run economical, even if these include, as they often must, building alterations.

The commonest types of cross-infection are the respiratory ones, such as tonsillitis, middle ear disease, 'colds in the head' and pneumonia. "If tonsillitis due to hæmolytic streptococci is accompanied by a rash, it is known as scarlet fever." Some thirty serological types of hæmolytic streptococci have been identified, and one and the same type may cause different effects in different patients. The tracking down of these types may be a very complex undertaking. Diphtheria, measles, chicken-pox, whooping cough, German measles, mumps and that disease about which much has been written recently, infective hepatitis, are other important infections which gain entrance by the respiratory tract. Gastro-intestinal infection may be a serious cause of death among infants in hospital. Epidemic diarrhœa, bacillary dysentery and diseases of the typhoid group may also occur. Wounds and burns may become infected, and abscesses, erysipelas, cellulitis and septicæmia may follow. Hæmolytic streptococci and staphylococci are the commonest causes of cross-infection of wounds. There are also the skin infections, impetigo, ringworm, scabies and pediculosis and infections of infants which may cause inflammations of the mother's breast. Nor should we concentrate all our attention on cross-infection of the patients. The nurses and other personnel need protection from it. Dr. Joyce Wright (*Brit. Med. J.*, 585, April 29, 1944), in her study of the sickness records of nurses in University College Hospital between 1936 and 1938, discusses this problem and emphasizes the need for further work on it. Although smallpox is outside the scope of the Medical Research Council's memorandum, it is interesting to note in passing that the theory that smallpox may spread from smallpox hospitals to the surrounding population by way of the air has been revived and supported by Dr. C. K. Millard (*Brit. Med. J.*, 629, May 6, 1944).

Infection in a hospital may be either from a clinical case, from a case which has not been recognized or is in its incubation period, or from a 'carrier' who is either a convalescent or harbours the organisms concerned without showing any symptoms. From any or all of these, infection spreads by way of the secretions or discharges or from the skin or from wounds. It can spread by contact with the patient or with his clothes or belongings, or by means of food or living vectors. But of special interest nowadays are infection by dust and by droplets of moisture, which can be projected 3–6 ft. through the air by talking, coughing or sneezing. Such infection may fall either on another person or on to bedclothes, utensils, food or on to the floor. Small droplets may evaporate and leave in the air minute droplet nuclei which are infected and may carry infection for considerable distances. The diagrams printed in this memorandum indicate that bacterial counts of the air show considerable increases when bed-making or floor-sweeping raises the dust. Dry floor-sweeping does this especially, and the dust settles on bedclothes, on the furniture, on food, toys, utensils, and so on. Pathogenic bacteria can live in floor dust for weeks or even months, and may be numerous there. Large numbers of virulent diphtheria bacilli have been isolated from the floor dust of diphtheria wards. It has been estimated that the floor sweepings of one ward in an ear, throat and nose hospital contained 100 million hæmolytic streptococci; and tubercle bacilli and pneumococci have also been obtained from floor dust. The bacteria of ward dust come mainly from bedclothes; and even the straightening of the clothes of one bed can raise the bacterial count of the surrounding air 100 times. The scales of skin, and hair and finger-nail cuttings found in dust also may carry pathogenic bacteria.

Surrounded by this multitude of enemies, what are we to do? War Memorandum No. 11 referred to above gives detailed directions. Among administrative measures are the abolition of the large open ward and encouragement of the modern tendency to build smaller units. About half the beds in a children's hospital should be in small isolated rooms, so that patients may be isolated if necessary, and so that those suffering from the same disease can be grouped in small wards. Patients should be grouped according to medical risks rather than according to age. Nurses' duties should be so allocated that risks of cross-infection are avoided. This applies especially to those engaged in the kitchens, on the preparation of feeding bottles or on toilet duties. Nurses should receive training in the risks of cross-infection and in hygiene and bacteriology. Similar rules should apply to visitors and to walking patients who may be helping the staff. Immunization and chemo-prophylaxis are also helpful. Labour-saving methods are also discussed. The use of trolleys, for example, in the serving of meals considerably reduced the 7½ miles walked by the staff of one hospital when they served one meal. The control of contact infection is discussed under the headings, handwashing, laundry, cleanliness of kitchens and food stores, the reduction of flies and other insect pests and, in children's hospitals, breast and artificial feeding.

The control of droplet infection is effected by adequate ventilation at all times and all the year round, by placing beds not less than 12 ft. apart, by the use of efficient face masks (which should not be carried in pockets and should only be used once), by the use of antiseptic aerosols insufflated into the air. R. J. V. Pulvertaft (*J. Hyg., Camb.*, **43**, 352; 1944) gives a valuable summary of recent work on these aerosols, and the same journal contains in earlier issues other accounts of research done on them. Prof. S. Mudd, of the University of Pennsylvania, has given us recently (*Brit. Med. J.*, 67, July 15, 1944) an American view of progress in the sterilization of the air. Ultra-violet irradiation is also helpful. Prof. L. P. Garrod (*Brit. Med. J.*, 245, Feb. 19, 1944) claims that his study of hospital dust shows that "ordinary, diffuse daylight even on a cloudy day and

even in winter in England, can be lethal to bacteria, and that glass is no absolute bar to this effect".

Dust-borne infection has received much attention recently. The interesting work quoted in this War Memorandum No. 11 shows that bedclothes should be handled gently and should not be allowed to touch the floor. The number of bacteria scattered from them is much reduced if they are impregnated with 'technical white oil'. Similarly, the treatment of wooden and linoleum-covered floors with spindle oil reduces the risk of scattering bacteria during sweeping. A striking diagram of results of bacterial counts of the air before and after oiling of floors illustrates this. Floors made of rubber, concrete or composition should be washed, vacuum-cleaned or sprinkled with damp sawdust before sweeping. For the same reasons dusting with dry dusters is banned. Food, sterile materials and so on should, of course, be protected from dust, and any article which falls on to the floor should be regarded as being contaminated. A recent paper by F. C. Harwood, J. Powney and C. W. Edwards, of the British Launderers' Association Laboratories (*Brit. Med. J.*, 615, May 6, 1944) describes a new technique for oiling bedclothes which incorporates the use of dilute water-in-oil emulsions. P. H. R. Anderson, J. A. Buchanan and J. J. MacPartland, in the same issue of that journal (p. 616), record their successful lowering of the rate of respiratory infections in a military barracks by the oiling of the floors with spindle oil. Joyce Wright, R. Cruickshank and W. Gunn, in the same issue (p. 611), have shown that oiling of the floors would not by itself be enough to control the spread of dust-borne hæmolytic streptococci in measles wards, but that oiling of all the bedclothes in addition to oiling of the floors did control this. The infection cycle is, they say, respiratory tract—droplets and discharges—bedclothes and garments—ward air during bed-making—ward dust—ward air during sweeping. Oiling floors thus attacks only the final links in this cycle, and oiling of the bedclothes and linen attacks the earlier ones.

The Medical Research Council memorandum gives in its appendixes lists of disinfectants and instructions for their use and rules for sterilization, isolation, and the application of dressings. The special requirements of maternity wards are also considered, and rules are given for the procedure to be followed when an infection does occur in a ward. G. LAPAGE.

## SAP-STAINS OF WOOD

SCHEFFER and Lindgren[1] present a summary of approximately ten years of field and laboratory work on sap-stains of wood. They state that market demands for wood products are becoming more exacting, making stained wood more difficult to dispose of. Losses from degradation are in general decreasing because of improved methods in controlling stain. Chemical, mechanical, and fungus stains are described and discussed as to symptoms, cause, timber species involved, effect on various wood properties, and control, the major emphasis being on blue stains caused by fungi. In the United States blue sap stains are of greater importance in the south than in any other region, although locally and seasonally important also on the west coast and in northern Idaho and contiguous regions. The chief factors influencing the development of fungus blue stains in sapwood lumber and other wood products are temperature, oxygen, and water. No correlation was found between wood density and susceptibility to stain. Flat-grained lumber was slightly more susceptible to stain than edge-grained, due to the greater number of rays exposed and the larger proportion of sapwood. Wood once seasoned and remoistened was less susceptible than unseasoned wood, but not significantly so. No difference was found in susceptibility to stain between winter-cut and summer-cut timber.

The fungi causing blue stain are disseminated by air, ips beetles, mites and possibly to some extent by the saws which cut the logs into lumber. Toughness (ability to stand loads applied quickly) of stained wood was significantly reduced as compared with unstained wood; but other mechanical properties were not significantly affected. Creosote under pressure penetrated considerably deeper into stained pine bolts than into matched unstained bolts. The presence of stain did not affect the yield or strength of paper made from the wood, nor did it affect the glueing and other properties of the wood. The commercial aspects of stain control in the southern United States are discussed, including the advantages and disadvantages of end-racking, end-piling, crib-piling, steaming, kiln drying, and chemical treatments. The chemicals most used at present are 'Lignasan' (ethyl mercury chloride plus inerts), 'Dowicide P.' (mixture in equal parts of sodium tetrachlorophenolate and sodium 2-chloro-o-phenylphenolate plus excess alkali) and 'Dowicide H.' (sodium tetrachlorophenolate plus excess alkali). The phenolates are more persistent on the lumber and more toxic to moulds. In poor seasoning weather, the control sometimes is erratic. It is estimated that three billion feet of pine and hardwood lumber was dipped or sprayed in 1936. Not only lumber but also other products, such as posts, barrel staves, shingles, lath, and exterior millwork now are treated to control stain.

One of the problems of commercial stain control is that treatments generally successful in preventing the development of sap-stain in lumber occasionally fail. As one of the basic approaches to the solution of this problem, Verrall[2] studied the relative importance and seasonal prevalence of wood-staining fungi in the southern United States. The studies were made in 1937 and 1938 in Louisiana, Mississippi, and Georgia. More than a thousand isolations were made from both logs and lumber of twelve species of trees, among which long-leaf pine (*Pinus palustris* Mill) and red gum (*Liquidambar styraciflua* L.) predominated. Blocks were inoculated with the isolated fungi to test their staining ability. The staining floras of both logs and lumber were very nearly alike. Those most important in pines were: *Ceratostomella pilifera*, *C. ips*, *Diplodia natalensis*, and other *D.* sp.; on hardwoods, *Endoconidiophora coerulescens*, *Ceratostomella pluriannulata*, *Diplodia natalensis*, and *Graphium rigidum*. *Diplodia natalensis* is of prime importance only in the summer months, *Endoconidiophora coerulescens* is of low incidence in the summer months, and *Ceratostomella pilifera* is relatively more frequent in winter than in summer, although of importance the year around. *C. ips*, *Diplodia sp.*, *C. pluriannulata* and Graphium fluctuate very little with season. *Diplodia natalensis* isolated from stained wood is identical with that isolated from cotton and other common agricultural plants in the region. Its prevalence in summer is thought to be due to a combination of ability to grow at high temperature, and

abundance of inoculum produced during this season on cotton and other plants.

Verrall[3] also identified the fungi associated with stain in green lumber treated with Lignasan and with Dowicide P. He found no special staining flora on the treated wood, and no evidence of a build-up of stains resistant to the treating chemicals. Some stain was obtained on most treated pieces of pine lumber under the severe conditions of the tests. *Endoconidiophora coerulescens* is probably the most important staining fungus on hardwoods, and treatments were less effective against this fungus than against other species. However, no difficulty was experienced in getting hardwood lumber to remain stain-free after treatment. *Graphium rigidum* and *Ceratostomella pluriannulata* were isolated in relatively greater numbers from Lignasan-treated than from Dowicide-treated wood. *Diplodia natalensis* was not isolated from treated wood. The greater part of the occasional severe staining of treated wood is attributed to poor handling practice, not to failure of the treatments themselves.

CLYDE M. CHRISTENSEN.

[1] U.S. Dept. Agric., Tech. Bull. 714 (1940).
[2] *Phytopath.*, 29, 1031 (1939).
[3] *Phytopath.*, 31, 270 (1941).

# FORTHCOMING EVENTS

## Tuesday, August 29

BRITISH PSYCHOLOGICAL SOCIETY (INDUSTRIAL SECTION) (at the National Institute of Industrial Psychology, Aldwych House, Aldwych, London, W.C.2), at 12.30 p.m.—Dr. K. J. W. Craik: "Proposed Work of the Medical Research Council's Unit of Applied Psychology at Cambridge".

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

READERSHIP IN PHYSICAL ANTHROPOLOGY—The Registrar, University Registry, Oxford (August 31).

SECRETARY to the Editorial Board of the 'Transactions' (must hold a Degree in Physics, Metallurgy or Engineering of a British University, or an equivalent technical qualification)—The Secretary, Institute of Welding, 2 Buckingham Palace Gardens, London, S.W.1 (August 31).

CHIEF ELECTRICAL ENGINEER AND MANAGER—The Town Clerk, Town Hall, Chichester (August 31).

PRINCIPAL ENGINEERING ASSISTANT on the permanent staff of the Buildings Department—The Clerk to the Kent County Council, County Hall, Maidstone (marked 'Principal Engineering Assistant') (August 31).

BOROUGH ELECTRICAL ENGINEER AND MANAGER—The Town Clerk, 4 Woodville Terrace, Gravesend, Kent (September 1).

ASSISTANT MASTER to teach BUILDING CONSTRUCTION, MATHEMATICS, TECHNICAL DRAWING AND MECHANICS at the Junior Building School, Cowes—The Director of Education, Education Offices, County Hall, Newport, I. of W. (September 1).

LECTURERS (two, full-time) IN PHYSICS—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex (September 2).

UNIVERSITY CHAIR OF STATISTICS tenable at the London School of Economics—The Academic Registrar, University of London, South Kensington, London, S.W.7 (September 4).

CHIEF STEAM TURBINE DESIGNER for a firm in the Midlands—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2249.XA) (September 4).

GRADUATE ASSISTANT (full-time, temporary) to teach MATHEMATICS AND SCIENCE—The Principal, Twickenham Technical College, Egerton Road, Twickenham, Middx. (September 5).

ASSISTANT LECTURER IN ZOOLOGY, and a DEMONSTRATOR IN ZOOLOGY—The Acting Registrar, The University, Leeds 2 (September 8).

ADVISORY OFFICER IN THE ECONOMICS DEPARTMENT—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (September 8).

CURATOR OF THE CITY MUSEUMS—The Town Clerk, Room 57, Civic Hall, Leeds 1 (endorsed 'Curator of the City Museums') (September 9).

LECTURER (full-time) IN BIOLOGY, and HEAD OF THE SCHOOL OF CHEMISTRY—The Principal, Leicester College of Technology and Commerce, Leicester (September 9).

ENGINEER (Water Supplies) by the Gold Coast Government Public Works Department—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.1094.A) (September 11).

DIRECTOR OF THE BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION—The Chairman of Council, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1 (marked 'Personal') (September 15).

ASSISTANT DAIRY BACTERIOLOGIST (temporary)—The Registrar The University, Leeds (September 15).

BOROUGH ENGINEER AND SURVEYOR—The Town Clerk, Town Hall, Walworth Road, London, S.E.17 (endorsed 'Borough Engineer and Surveyor') (September 22).

LECTURER IN VERTEBRATE ZOOLOGY—The Secretary, The University, Edinburgh (September 25).

CHAIR OF ELECTRICAL ENGINEERING—The Acting Registrar, The University, Leeds 2 (September 30).

CHAIR OF BIOLOGY in Victoria University College, Wellington, New Zealand—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (September 30).

PRINCIPAL OF THE HACKNEY TECHNICAL INSTITUTE, and PRINCIPAL OF THE SOUTH-EAST LONDON TECHNICAL INSTITUTE—The Education Officer (T.1), County Hall, Westminster Bridge, London, S.E.1 (September 30).

PROFESSOR OF PHYSICS—The Registrar, University College, Singleton Park, Swansea (October 18).

LIBRARIAN—The Librarian, Queen's University, Belfast (October 31).

CHAIR OF PSYCHOLOGY in the University of Sydney—The Secretary, Universities Bureau of the British Empire, c/o University College Gower Street, London, W.C.1 (October 31).

TECHNICAL ASSISTANT (female, non-resident) for Clinical Laboratory Work—The General Superintendent, Royal Infirmary, Manchester.

TEACHER mainly for MATHEMATICS AND ENGINEERING SCIENCE in the Junior Technical School and in Senior Day and Evening Classes—The Principal, County Technical College, Gainsborough, Lincs.

LECTURER IN ELECTRICAL ENGINEERING with special reference to Design of Electrical Machinery—The Principal, Faraday House Electrical Engineering College, 62–70 Southampton Row, London, W.C.1.

TEACHER OF ENGINEERING DRAWING AND MECHANICS in the Junior Technical School for Boys—The Principal, Wimbledon Technical College, Gladstone Road, London, S.W.19.

TEACHER (full-time, temporary) OF MECHANICAL ENGINEERING SUBJECTS in the Technical College and Junior Technical School—The Principal, Technical College, Talbot Road, Stretford, Lancs.

DEMONSTRATOR IN ANATOMY—The Secretary, University College, Gower Street, London, W.C.1.

PRINCIPAL of Natal University College—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

Ministry of Agriculture and Fisheries. Bulletin No. 85: Rotations. By Dr. H. G. Sanders. Pp. 18. (London: H.M. Stationery Office.) 4*d*. net. [317

Tractor Ploughing. (N.I.A.E. Publication No. 503/44.) Pp. 40+iv. (York: National Institute of Agricultural Engineering.) 9*d*. [28

Annual Report of the Council of the Yorkshire Philosophical Society for the Year 1943. Pp. 28. (York: Yorkshire Museum.) [28

University of Bristol. Annual Report of the Agricultural and Horticultural Research Station (the National Fruit and Cider Institute), Long Ashton, Bristol, 1943. Pp. 172. (Bristol: The University.) [38

Ministry of Health: Nurses Salaries Committee. Report of the Mental Nurses Sub-Committee. (Cmd. 6542.) Pp. 45. (London: H.M. Stationery Office.) 9*d*. net. [48

Science in the Universities. Report submitted to the University Grants Committee of the Treasury. Pp. 44. (London: Association of Scientific Workers.) 1*s*.

## Other Countries

Proceedings of the United States National Museum. Vol. 94, No. 3171: Catalog of Human Crania in the United States National Museum Collections—Non-Eskimo People of the Northwest Coast, Alaska and Siberia. By Aleš Hrdlička. Pp. 172. (Washington, D.C.: Government Printing Office.) [257

National Research Council: American Geophysical Union. Transactions of 1942. Part 1: Reports and Papers, Joint Regional Meetings, Section of Hydrology (a) Dallas, Texas, (b) Pasadena, California. Pp. 172. 1.25 dollars. Part 2: Twenty-third Annual Meeting, April 3 and 4, 1942, Washington, D.C., Reports and Papers, General Assemblies and Sections of Geodesy, Seismology, Meteorology, Terrestrial Magnetism and Electricity, Oceanography, Volcanology, Hydrology and Tectonophysics. Pp. 173–740. 4.50 dollars. Transactions of 1943. Part 1: Twenty-fourth Annual Meeting, April 23 and 24, 1943, Washington, D.C., Reports and Papers, General Assembly and Sections of Geodesy, Seismology, Meteorology, Terrestrial Magnetism and Electricity, Oceanography, Volcanology and Tectonophysics. Pp. 332. 3.50 dollars. Part 2: Twenty-fourth Annual Meeting, April 23 and 24, 1943, Washington, D.C., Reports and Papers, Section of Hydrology. Pp. 333–784. 4 dollars. Part 3: Reports and Papers, Joint Regional Meeting, Section of Hydrology, Western Snow-Conference, Corvallis, Oregon, June 16, 1943. Pp. 102. 1 dollar. (Washington, D.C.: National Academy of Sciences.) [257

## Catalogues

X-Ray Darkroom Practice. Pp. 32. Ilford Lead Screens for Industrial Radiography. Pp. 6. (Ilford: Ilford, Ltd.)

Iodatol in Hysterosalpingography. Pp. 8+4 plates. Dienoestrol B.D.H. Pp. 2. Thiouracil B.D.H. (2-Thio-6-oxypyrimidine). Pp. 2. (London: British Drug Houses, Ltd.)

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CONTENTS



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# SCIENTIFIC AND INDUSTRIAL RESEARCH.—II

WE have already noted that one of the first problems in the development of an adequate strategy of research is the re-examination of our whole educational system with respect to the provision of adequately trained and broadly educated workers for scientific research, and the balancing of the immense needs for technical and scientific training by competent education in the liberal arts and humane studies. This involves not merely an adequate supply of competent investigators, but also of those capable of directing research effectively, as well as of the laboratory technicians necessary for the efficient use of the fully trained research worker. Again, since both the support of research in the first instance, and the utilization of its results afterwards, involve some understanding by the community generally of the value and significance of scientific research, we are concerned also with the general education of the community and not merely with education at the university level.

This point has not yet been as fully appreciated by scientific workers as is desirable, despite the attention which has been focused on education in general by the Government White Paper on Educational Reconstruction, the debates leading up to the new Education Act, and the recent series of reports such as the McNair Report on Teachers and Youth Leaders, the Norwood Report on Curriculum and Examinations in Secondary Schools and the still more recent Fleming Report on the Public Schools and the General Educational System. This neglect is the more important as the attention given to scientific and technical training in the Government's own White Paper and the Norwood Report, to say the least, can scarcely be regarded as adequate. To some extent this has been corrected in the Statements issued by Nuffield College on "Industry and Education" and on "Problems of Scientific and Industrial Research", the latter of which reiterates that the foundations for a sound and scientifically minded industry must be laid in the schools by good grounding in mathematics and in the principles and methods of science, coupled with a thorough mastery of the English language and a broad cultural approach to all subjects. "We live in a world in which science lies at the very roots of community, and a mastery of scientific thinking grows more and more indispensable for the successful practice of the arts of life. The culture of the modern age, if it is to have any meaning, must be deeply imbued with scientific ways of thought."

Strong support for this point of view can be found in the report of the Chemistry Education Advisory Board on the Education and Training of Chemists, and in the report of the Federation of British Industries Committee on Industry and Education, but it is one that will demand the sustained support of scientific workers if it is to be achieved in practice. None the less, it is to the universities that we may well direct our attention in the first instance. Their place in the strategy of research, as the main source

of supply, both direct and indirect, of the type of personnel required, is unique and unchallengeable. It is this position that must be considered before we consider the further question of their place in, or relation to, whatever organization of research may be desirable to implement our strategy.

Attention has been directed to the universities as a source of supply for the research workers required in industry and elsewhere in several reports. While in most of these papers and reports the short-range and long-range problems are clearly distinguished, the more fundamental problems involved have seldom been discussed. The universities are social institutions, just as research from one point of view is a social process, and any scheme of university expansion with its concomitant calls for larger endowment must make plain to the ordinary citizen what social purposes such expansion will serve. That presupposes a re-examination of the fundamental questions of the functions of the universities and their place in the society of to-day. As Rashdell has pointed out, new needs must be met by new machinery. University institutions must undergo perpetual modification in the future, as they have undergone perpetual modification in the past.

But Rashdell's further observation in this connexion is worth noting. "It is well," he adds, "in this as in wider fields of social, political and religious organisations, as far as possible to preserve historical continuity." That observation is worth remembering for the help that attention to such historical continuity may give in developing a social philosophy. A false philosophy, as Dr. Conant recently noted, was one of the reasons for the triumph of Nazism in Germany; and the University Grants Committee in its last quinquennial report recognized the special responsibilities of British universities in this field in view of the suppression in European universities of independent thought and critical discussion. The late Prof. J. L. Stocks was even more explicit. "What is wanted," he wrote in an essay "On the Need for a Social Philosophy", "is a philosophic discipline, encouraging and promoting the careful exposition and discussion of the pre-suppositions of social organisation on every side. No such discipline exists in this country at present. Our generation is not being given in these matters the tools necessary for coming to a sound critical judgment, and . . . philosophy alone has the power to give them those tools. When men do not know the faith by which they live, they will be apt inadvertently to betray it."

In the attempt to restate the functions of the universities in the modern world, too little regard has been paid to the experience of the past. That can afford a surer guide to our grand strategy than preoccupation with the minor tactics required to deal with some transient if embarrassingly urgent problem. There could in fact be no finer starting point for the reconsideration of the place of the universities in the society of to-day than Rashdell's study of the medieval universities from which we have already quoted. "The two most essential functions which a true university has to perform and which all universities have more or less discharged amid the widest possible variety of system and method and organisation . . . are to make possible the life of study, whether for a few years or during a whole career, and to bring together during that period, face to face in living intercourse, teacher and teacher, teacher and student, student and student." Thus Rashdell has crystallized three of the four principles which guided the Association of University Teachers in its approach to university problems as set forth in the report on university developments: the pursuit of knowledge, not controlled or dominated by any private or corporate interest; the dissemination of knowledge and culture; and the communal aspect—universities are schools of communal living, in which the development of students as individuals and their development as social beings are equally important.

Those three principles are more or less explicit in the great bulk of the reports and books or papers that have discussed the problems of university development, whether in regard to research or teaching, in recent years. The fourth principle, that universities are a part of society, both materially and intellectually, and bear a direct responsibility, and must therefore study the application of organized knowledge to practical problems, and train men and women for particular tasks finds almost equally general acceptance.

It is of special interest, to the scientific worker, to note how well these ideas are brought out by Dr. F. R. Leavis in his sketch for an "English School" in "Education and the University". This plea for a liberal or humane school at first appears to be remote from their own concern, but Dr. Leavis has crystallized his objective in words which show unmistakably its relevance. Strongly contesting subjective views, he visualizes a university as a focus of humane consciousness where intelligence, bringing to bear a mature sense of values, applies itself to the problems of civilization. That is the reason for his plea for a school of the humanities. He aims at producing minds that will approach the problems of modern civilization with an understanding of their origins, a maturity of outlook, and a sense of human possibilities, difficult of achievement, that traditional cultures bear witness to and that it would be disastrous to lose sight of for good.

Whatever view we may take of the functions of the universities or of their place in our strategy of research, we cannot ignore their inherent possibilities of leadership. Just as in the field of thought a university stands for adventure, so in regard to society the university plays its greatest part as a stabilizing factor. Sir Walter Raleigh pointed out that a university must be perpetually alert to discard superseded methods and to detect the importance and significance of new studies and new ways of approach, encouraging adventure and giving to each a place in the long line of pioneers who are pushing forward the boundaries and claiming new provinces. While serving as a repository of the reasoning of the ablest minds attracted to it, the university must continue its vital function of checking the dangerous extremes to which all institutions with power are subject, and above all at this time those extreme

tendencies of modern civilization shown in the modern State and in the tyranny of opinion.

But if it is not part of the duty of a university to inculcate any particular philosophy of life, it is, as the University Grants Committee recognized, most assuredly an essential part of its work to assist its students to formulate adequate philosophies of life for themselves. Only so can the universities make their great contribution to meet the danger to which Prof. Stocks directs attention; and there is here a very important practical point to be considered in relation to demands for increasing the range of technological studies at the universities. In a passage that deserves to be noted particularly in regard to the extra-mural activities of the universities and their part in adult education, Rashdell, after a warning not to lose or lower the ideal of the university as the place *par excellence* for professed and properly trained students, not for amateurs or dilettantes or even for the most serious of leisure hour students; for the highest intellectual cultivation, and not merely for elementary instruction or useful knowledge; for the advancement of science, and not merely for its conservation or diffusion; continues with the plea that it is the place "where different branches of knowledge are brought into contact and harmonious combination with one another, and where education and research advance side by side".

Prof. D. W. Bronk pointed out in his paper on the discovery and interpretation of biological phenomena in the symposium on the "Organisation, Direction and Support of Research" arranged by the American Philosophical Society last November that the departmentalism of science has tended to become more restrictive and the boundaries of teaching departments have insensibly created artificial barriers to the free range of inquiry. Questions as to the barriers we have erected around disciplines and departments must be frankly faced in considering the replanning and reorganization of the universities to meet post-war needs. Nowhere will more fundamental thinking be required than at this point and nowhere more than here will the universities need, as has been well said, "official window cleaners whose chief function is perpetually to open windows and let in air—the colder the better".

But there is more involved here than decisions as to how far to retain some of these compartments for administrative convenience or the clear thinking about the impediments they offer to effect research and the limitations they impose on the character of the training we give our future investigators. As already indicated, we have to define the relation of technology to university studies. Technological studies have significance not only in regard to the survival of the nation and the needs of individuals, but also to the advancement and the unity of knowledge itself. In fact, technological requirements are an important factor enforcing the consideration of a new synthesis of scientific effort. Nevertheless, we are, as Mr. P. R. Morris rightly said in a recent lecture to the Royal Society of Arts, "in danger of forgetting, and the present haphazard organization of courses and studies encourages us to continue to forget, that the differentiation of knowledge into faculties and subjects can easily be regarded as a division of knowledge itself. There is here a fundamental question of principle of the highest importance and also a practical problem of systematisation and organisation".

That fundamental question has to be considered both from the point of view of the universities themselves and from that of their relations with the technical colleges and the place of the latter in the educational system. It is not the only principle which should determine whether or not the technical colleges should be developed into institutions of university rank but independent of the universities, but it is an important factor bearing on our decision. Almost a generation ago, Prof. Arthur Smithells argued powerfully that the isolation of professional or technological studies and their cultivation in separate institutions was fraught with serious dangers and disadvantages, and advocated the embodiment of professional and technical studies in our universities, and for the reason that a wider outlook would be thereby promoted. The Committee on Post-War University Education of the British Association, in its recent report though without reasons given, supports this view and considers that the development of technical colleges into institutions of university rank, but independent of the universities, should not be encouraged. Rather, British colleges carrying out technological work of university standard should be associated with their regional university, as the Imperial College of Science and Technology in London, the Royal Technical College in Glasgow and the College of Technology in Manchester.

From this view Sir Alfred Egerton dissents. He considers it highly important that there should be in Great Britain an institution such as the Imperial College, somewhat similar to the Massachusetts Institute of Technology; there should be one in the south of England, one in the north and one in Scotland, closely associated with the universities, with strong post-graduate schools and providing undergraduate teaching. There have been other powerful pleas for such institutes from the research point of view. But it is important that there should be no confusion with other proposals to advance certain university colleges to full university rank, which is a possibility also contemplated by the British Association Committee. Such proposals obviously are related primarily to the quantitative aspects of university expansion—the size of our university population and the size and number of the universities to cater for it.

These questions have been raised already, notably by Sir Ernest Simon in his pamphlet on the development of British Universities, and by the Association of University Teachers in the report already mentioned, where tentatively it is suggested that a university in Great Britain should range in size from 2,000 to 5,000 students, with residential accommodation for a large number of students. On this basis a national policy would first aim at building up the smaller universities to the optimum size and sub-

sequently at transforming some at least of the university colleges into true independent universities to provide the balance of whatever accommodation may be required to meet the needs of the university population at which it is decided to aim. Some approximate figure must clearly be adopted as target if any real plans for university expansion are to be formulated. That estimate will depend in part only on the demands for research workers and for teachers, for it must be related to the general question of university finance and the distribution of what increased grants may be available, not merely for expansion but also for improving the conditions and standards in existing departments. In fact, until we have attempted to formulate some reasonable estimate as to the student population at which we should aim, whether the pre-war standard of about 50,000, with better selection and higher standards, a twenty per cent increase, the fifty per cent increase suggested by the Association of University Teachers, or a hundred per cent increase, we can scarcely decide on what increase in grants is desirable, and this is a notable omission in the report of the British Association Committee.

It will be recognized, of course, that closer co-operation between the universities, particularly in regard to the development of schools of research and teaching, the elimination of redundancy, and the planning to cover existing gaps may offer some possibilities of economy to offset some of the increase. But whatever the target number we select, we must have regard, first to the principles already adumbrated; second, to the danger of opening the doors too wide and not retaining first-class staff owing to competition; and third, to the capacity of society to utilize the students when qualified. On the second point it may be observed here that the question of status and standards among the university staffs is of first-class importance. Quality must come before quantity and there must at least be that much relation between the financial rewards in a university career, whether of teaching or research, and those elsewhere, to ensure that a due proportion of the ablest minds of each succeeding generation are attracted to such careers. Accordingly no policy of university expansion which neglects to bring such matters as staff salaries and grading, superannuation, and the like, more into keeping with conditions in industry will achieve its purpose. Beyond this, if a university is a free and graded association of free men and women united in a corporate organization to study apart and develop truth, no limits can be set to the institutional forms its activities may take or to the spheres of conduct in which it may fruitfully intervene, other than those which in practice mere prudence will dictate to avoid the unwise diffusion of resources.

The third point requires somewhat fuller consideration. Mannheim has directed attention to the dangers which arise when there are more persons on the intellectual labour market than society as it is requires for carrying out its intellectual work. It is, of course, true that one of the reasons for expanding the universities of Great Britain is that at present industry is making insufficient use of scientific knowledge because it does not employ in the right positions a sufficient number of those trained to use such knowledge. It is also true that the demand for such workers has increased and that progressive firms already anticipate a difficulty in finding sufficient recruits of the requisite calibre unless the university schools of research are expanded. None the less, the warning which Mannheim gives of the effect of over-supply on society in the lost social value of the intellectual professions and the belittling by public opinion of cultural and intellectual activity is not one to be disregarded if we hope to plan for a new society and to preserve the essential elements of freedom and culture; and that warning is powerfully enforced by experience in Germany.

What, then, in short should be our basic strategy with regard to the universities and research? First, we must look to them for the supply of the research workers required in all branches of science and for industry, for government institutions and departments, and for fundamental research at the universities themselves. Second, we must look to them ultimately for the supply of leaders in all walks of society competent to apply scientific knowledge to the service of industry or of the nation as a whole. Thirdly, we must look to them to play a vital part in that work of adult education through which alone we can hope for a society in which policies and plans based on scientifically ascertained facts can be assured of reasoned and general support. Finally, these teaching functions must be in balance with the equally vital function of research of extending the bounds of knowledge.

That last task must be considered more fully in connexion with the actual organization of research. It is sufficient to note here that teaching must be in vital touch with research, and that we may have to consider more carefully to what extent the two functions can be combined in the same staff. That there must be the vital contact is not denied, nor the value to the research worker himself of attempting to expound to others the significance of the field in which he is working. What we are concerned with is raising the standard of teaching and with giving to the really great teacher with a genuine talent for exposition and for inspiring others the full scope and encouragement that he deserves. Such teachers are not necessarily great investigators also, and one reason for the inadequate appreciation of science is certainly the failure of scientific workers themselves to accord fitting status and prestige to the great expositor in their ranks. We would do well, as Sir J. J. Thomson urged, to pay far greater regard in our appointments to teaching posts, whether of professors or lectureships, to the powers of the candidates to present a subject in a clear and attractive way.

These relations will demand especial consideration with regard to the social sciences, where university study has important contributions to offer in clarifying the issues involved in many social and economic problems to-day, both in regard to methods and assumptions, and the problem of values and moral issues. Never was it more important that the univer-

sities should be places where thought and disinterested inquiry are pursued on the highest level, and where the best minds of each generation are trained for intellectual achievement. Teaching and research alike in the universities must be pursued in a spirit entirely free from bias, prejudice or preconceived ideas.

The first two tasks, however, must be related quantitatively to some reasonable estimate of the needs of society for university graduates, first in the immediate post-war period, but finally to the long-term needs. That relation should be sufficiently flexible to minimize any over-training likely to hamper transfer or adjustment as the needs of society shift slightly from one field or branch of science. Clearly such flexibility must be had in mind in considering afresh the content of university curricula. Clearly also such quantitative relations involve a much fuller study of the structure of society and of the technique of social adjustment, for which provision also must be made in the organization set up to implement our strategy. Furthermore, limitation of the numbers of students entering the universities presupposes, as the British Association Committee emphasizes in its report, much more care in selection. When the number of places is limited, there can be no longer room except for those possessing the appropriate qualities of ability and character, though originality and creative needs should be our first concern here.

Qualitatively, all these four tasks alike involve loyalty to the conception of the university as a place where teaching and research are linked inseparably, set forth so consistently by Rashdell and by so many of those who have since touched this theme, but by none better than by Haldane: "A place of research, where the new and necessary knowledge is to be developed; a place of training where the exponents of that knowledge—the men who are to seek authority—are to be nurtured, and receive their spiritual baptism. Such a university cannot be dependent in its spirit. It cannot live and thrive under the domination either of the Government or the Church. Freedom and development are the breath of its nostrils, and it can recognize no authority, except that which rests on the right of Truth to command obedience".

Whatever the magnitude or directions which university expansion may take, those ideals must be served, and such service will assuredly demand all the inspiration and vision that the universities' greatest traditions of independent and fearless inquiry and faithful service can supply. In a memorable passage Rashdell described the service the University of Paris rendered in checking in France the dangerous tendencies of the Inquisition in Spain.

"The political position of Paris gave its university a place in the political and ecclesiastical world which no other university has ever occupied . . . a body of educated men, protected by the sanctity of their order against the hand of secular justice, possessing the right of public meeting, of free debate, and of access to the throne. The tendency of a body so situated to become a great organ of public opinion, a channel through which the Court might address itself to the nation, and the voice of the nation reach the Court, was strengthened by the deliberate policy of the House of Valois".

The point which Rashdell here makes that at a particular crisis in the history of Europe the universities performed the function which is discharged at the present time by the Press, the platform or even by the polling-booths is of wider significance than as illustrating that Rashdell was fully aware of the social functions of the universities. It is even more explicitly shown in his reference to the University of Oxford: "It was not as a great semi-ecclesiastical corporation but as a centre of speculative thought and of religious life, that Oxford contributed to the making of English history. It was through her influence upon the religious life of England that the University of Oxford did at one supreme moment open a new page in the history of England and of the civilized world."

No one can ponder such passages without glimpsing something of the possibilities if the universities recognize the opportunities which confront them and face the task of reconstruction and development in a like spirit. There is need for fundamental thinking, for close analysis and wise organization and marshalling of resources, which however much they are augmented are bound to be limited. But creative thought and wise administration alike will be most fruitful as in loyalty to these ideals and traditions of the past the universities seek to discover the new forms and opportunities of service which are opening before them, and to grasp them surely in ever more active and intimate co-operation with the whole community upon which in part their own spiritual and intellectual effectiveness in enriching the national life depends.

## THE APPRECIATION OF SCENERY

**The Beauties of Scenery**
A Geographical Survey. By Dr. Vaughan Cornish. Pp. 128+16 plates. (London: Frederick Muller, Ltd., 1943.) 6*s*. net.

THE scientific study of scenery, which owed so much to Sir Archibald Geikie, Lord Avebury, and later to J. E. Marr, has benefited greatly in recent years from the writings of Dr. Vaughan Cornish. He has not only devoted himself to the problems of the preservation of scenery and to the related question of national parks, but has sought also for a new approach to the appreciation of scenery. He has endeavoured to develop an analytic study of beauty in scenery, and in this new book he has sought to provide a manual on this subject, which he hopes may be useful as a basis "for education in scenic amenity in preparation for the re-planning of town and country".

His approach to the scenery of an area is influenced by his geological and geographical interests. Indeed it is certain that any real understanding of scenery must have a geological basis (especially if geology is taken to include physical geography). It may readily be admitted that many have a warm appreciation of the beauties of scenery without such a geological basis; but it can be claimed that some knowledge

of the geological structure and the moulding of the foundations of a landscape clarifies the vision and enlarges the interest. It is regrettable that so little reference is made to these simple geological factors in school work. What is needed is not so much a formal study of the science with numerous technical terms, but rather an indication of some of the influences of the rocks on life and landscape.

The author of this little book has set himself a considerable task in attempting to cover a very wide field in such a small compass. In his first chapter he has discussed the sky by day and night, clouds, rainbows, the Arctic summer, eclipses, stars, comets and the aurora, all in eighteen pages.

But still more compression has been required in the second chapter, in which Dr. Cornish deals with "Land and Water". The coast-line of southern England illustrates many of his early points, but after little more than two pages we are rushed away to the coasts of the Riviera and to Norway and New Zealand. The scope is so wide that the discussion is tantalizingly brief, and the change of topic is so sudden that there is a suggestion at times that one is reading a series of notes rather than a connected study. Yet from this chapter the reader will gather some indication of the geological factors affecting scenery, and it may be hoped that he will be stimulated to seek more elaborate accounts of the landscapes familiar to him. Some suggestion of suitable books for further reading on these topics would have been useful.

After a chapter on natural vegetation and wild life, in which mammals and birds are taken to be as essential a part of the scenery as man himself (especially the colours of his clothing), there are two chapters on the scenery of civilization. Here Dr. Cornish gives an account of many types of architecture, from Swiss chalets and Cotswold cottages to the buildings of Washington and Rome, from megaliths to skyscrapers.

In his last chapter the author has somewhat extended the meaning of scenery to include "indoor scenery". This naturally affords him an opportunity of writing about the architecture of interiors of houses and churches; but it is rather surprising to find the theme still further enlarged by the inclusion of screens and mural painting, and then of furniture, carpets, convex mirrors, and finally, the engraving of coins.

There is, however, one approach to scenery to which the author makes no reference, but which will surely be of increasing interest in the future, that is, the aspect of the country as seen from the air. While there are some who find air journeys intolerably dull, there is much of interest and of beauty to be seen from the air which is not apparent from the ground: the wide sweep of landscape features, the changes in crossing the broader climatic belts (for example, over Africa), and the amazing colours and patterns of shallow seas when flying along a coast-line, especially when the water is clear. Even aerial photographs, the use of which is certain to increase after the War, show many aspects of scenic design. With the increase of civilian flying there will be an opportunity to provide passengers with data to make journeys more fascinating and to widen their interest in the history of scenery.

It remains to add that Dr. Cornish's volume is illustrated by thirty-two photographs showing many of the features with which he deals.

A. E. TRUEMAN.

## CHEMICAL EXAMINATION OF WATERS

**The Chemical Analysis of Waters, Boiler- and Feed-Waters, Sewage, and Effluents**

By Denis Dickinson. (Blackie's 'Technique' Series.) Pp. xii+140. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1944.) 6*s*. net.

THIS latest addition to Blackie's "Technique" series of handbooks maintains the high standard of earlier volumes. It is a very practical guide to the wide subject of water analysis, and has been written primarily to meet the needs of the industrial chemist.

A chemical analysis of water may be undertaken for a variety of purposes; for example, to test its suitability for drinking, washing, feeding boilers, or discharge to a stream. It will thus be realized that the tests to be applied will depend very largely upon the purpose for which the analysis is made; and the book under review deals with most of the tests which could come into consideration. The details given of the tests are sufficient to enable the industrial chemist to carry them out, but the book would have been enhanced in value if the author had indicated the interpretation to be placed upon the results of the analysis.

Perhaps in no branch of chemical analysis are there so many tests as there are in water analysis which depend for their result upon a strict observance of the various conditions under which the test is carried out. This is sufficiently indicated in the several chapters of the book dealing with oxygen tests for organic matter, the biological oxygen demand, and determination of albuminoid nitrogen. These facts cry out for a standardization in methods of carrying out tests, and it is most important that greater uniformity should prevail, so that the results obtained by one analyst may be comparable with those obtained by another. The author does touch upon this aspect of standardization, both in regard to the methods of carrying out the tests and the method of expressing results, but he does not take sides for or against.

The fourteen chapters of the book are very well written, and although it might be considered invidious to select any chapters for special mention, those dealing with hardness and boiler-feed and boiler-waters are specially worthy of praise. It may be that they indicate some special interest of the author.

It is important when reading a book of this kind to bear in mind that chemical analysis alone only affords an incomplete picture of a water, and that in considering, for example, its suitability for drinking purposes, the chemical analysis should be supplemented by a bacteriological examination. Such an examination is perhaps not always so important in connexion with trade effluents.

The book presents a very wide review of the subject with which it deals, and the reference to fluorine as being responsible for the condition known as dental fluorosis is specially to be welcomed. The latest information on this subject has been included. Reference might have been made to the radium content or radioactivity of waters, a subject which is deserving of more attention than it has received in the past.

In an appendix the author includes typical analyses of various kinds of water, including drinking water, sewage and sewage effluents and a variety of trade

effluents. Typical analyses of waters used for locomotive boiler-feed are also included.

In conclusion, the book is a useful compilation which should prove of value not only to the industrial chemist but also to all those who have to examine waters as to their suitability for the many purposes for which they find a use. As the author says, he has only attempted to include a fraction of the known methods of analysis, and for other methods it would be necessary to refer to the larger text-books; but as already stated, he has provided an excellent guide to the wide subject of chemical analysis of waters.

H. T. CALVERT.

# NUTRITION AND HEALTH

## Nutrition and National Health

Being the Cantor Lectures delivered before the Royal Society of Arts, 1936. By Major-General Sir Robert McCarrison. Pp. 75+3 plates. (London: Faber and Faber, Ltd., 1944.) 6*s*. net.

THIS attractively written book is a re-publication of the three Cantor Lectures delivered to the Royal Society of Arts in 1936. The author was formerly director of research in nutrition in India.

The first lecture is devoted to the physiology of nutrition; the second to the relation of oxygen, water, proteins, mineral salts and vitamins to health and illness; the third to the effects of nutrition on national health. The whole constitutes a useful introduction to the study of a subject much in the public mind at present, illustrated throughout by references to the author's work in India and to results obtained in Great Britain.

If criticism is to be made, it might suggest that the opportunity of reprinting could have been taken to include some account of the creation and work of the Nutrition Society, that more recent researches might have been included and that more space might have been given to nutrition of those animals on which we depend for our food supplies and to the effects of the national food policy during this War. The education of the public, the medical student, the medical practitioner, the school teacher and others for which Sir Robert appeals has surely been going on vigorously in recent years, and the public is already very conscious of food values. It has learned, too, the pleasure and advantage of growing its own greenstuffs and of producing its own eggs, thanks to the national policy of aiding both these enterprises. It may still be true that greenstuffs have already lost much of their food value before they reach the poor, but this can only be true of large cities and only of parts of these; for everywhere within and outside them allotments have been growing vast quantities of vegetables for some years, and it is a little late in the day to advocate, as Sir Robert does, the extension of these and of facilities for keeping poultry. There are parts of the country, indeed, in which people cannot eat all the greenstuffs that they grow.

The book is a beautiful example of what can be done within the limits of the authorized war-time standards of economy. Some readers will wonder why, if books like this can be produced within such limits, more of them do not appear. For the same reason some may even wonder whether any other standards will be really needed after the War.

G. LAPAGE.

# PHILOSOPHY OF ORGANISM

## A Contribution to the Theory of the Living Organism

By Prof. W. E. Agar. Pp. 207. (Melbourne: Melbourne University Press; London: Oxford University Press, 1943.) 12*s*. 6*d*.

THE keynote of Prof. Agar's book, in which he has drawn freely upon the materials both of philosophy and biology, is frankness, directness and lucidity. At least some preliminary contact with the biological philosophy of Whitehead is demanded of the reader. The main thesis is that all living organisms are subjects, that all, possibly including even the simplest, are organizations of subjects, and that the characteristic activity of a subject is the act of perception. In this perception he sees the establishment by the subject of its causal relation with the external world. Even in inanimate objects, process is conceived as one of experience or feeling. In developing this thesis, in which Whitehead's philosophy of organism is freely invoked, many aspects of the organism, especially those of which we have knowledge from experimental investigation, are discussed with refreshing lucidity.

In treating the component parts of living organisms, even at the level of cells or cell aggregates, as feeling, perceiving subjects, the author realizes that he is introducing an interpretation which is likely to be opposed or denied by many biologists. Thus, for example, he writes: "As perception always carries with it the anticipation of further relevant experience, and the meaning of the present experience includes action, or potential action, appropriate to the anticipation, the notion of final causation is involved . . . the anticipatory aspect of causation compels us to recognize the reality of final causation in all perceiving organisms". Thus, in this connexion the teleological nature of causation is recognized. The author is well aware that in adopting this point of view he is treading dangerous ground—that in which science and philosophy stand in danger of becoming confused—but he is prepared to maintain his position and to justify his views. The thesis which, in some respects, is the antithesis of a mechanistic theory, thus rejects the view that "biology is only a science so long as it is only biochemistry and biophysics".

Consideration is given to such topics as purposive action and its interpretation, the unity of the organism considered in the light of experimental studies, biological fields, *Gestalt* psychology, animal behaviour in terms of perception, and aspects of embryonic development and its interpretation as behaviour. In a final chapter the conclusions reached are considered in relation to the Darwinian and Lamarckian views of the process of evolution, a verdict in favour of the former being given. If his thesis is correct, says Prof. Agar, biologists must accept perception as one of their ultimate data; but he admits that even in imagination it is not easy to trace "the detailed course of the evolution of the higher out of the lower types of perception".

No adequate short review of this book is possible, for the book is itself commendably short, and while full of meat, yet does not give the impression of being crowded. If biologists admit that they should give heed to the trend of thought in Whitehead's philosophy of organism, as sooner or later it seems they must, then they would do well to read this book.

# CURRENT PROBLEMS OF VISUAL RESEARCH

By DR. W. S. STILES
National Physical Laboratory

## Variations in the Visual Threshold

THE problems of visual research discussed in this lecture mainly concern the sensitivity of the retina. A very general test of retinal sensitivity is the determination of the threshold increment, or, briefly, the threshold. The eye views a given distribution of brightness—which may be varying with time in a prescribed way—and, at a given moment, a small additional light stimulus is applied at a particular point in the visual field. By repeated trials with different intensities of the additional stimulus, the critical intensity can be determined at which the observer sees the stimulus on fifty per cent of occasions. This threshold increment, or better, its reciprocal, provides a measure of the sensitivity of a given part of the retina at a given time. It can be determined under a wide range of conditions, and by varying the angular size, exposure time and colour of the test stimulus the response can be made to depend in different degrees on different mechanisms in the retina.

In a typical determination of the threshold increment by the method now commonly adopted, an S-shaped curve is obtained showing how the chance of seeing the test stimulus varies with its intensity. Frequently, there is a considerable range of stimulus intensities, of the order of 3 to 1, within which it is a matter of chance whether the stimulus will be seen. This range of indefiniteness is commonly attributed to uncontrollable variations in the sensitivity of the retinal or post-retinal processes in the observer. Some years ago, however, it was suggested in several quarters[1,2,3] that for an eye in its most sensitive state the threshold is so small that *quantum fluctuations in the stimulus* might be responsible for a part of the observed scatter.

The threshold, expressed as the number of quanta of radiation entering the eye from the test stimulus, has its smallest value when the eye is fully dark-adapted and when the test stimulus is a very brief flash (0·01 sec. or less) from a point source (10 min. diameter or less) of green light ($\lambda = 510\ m\mu$) which is viewed by slightly averted vision, so that the image is formed on the parafoveal retina. Under these conditions the threshold has a value of about 50 quanta. Because of the corpuscular nature of radiation, any physical apparatus designed to flash a fixed number, say, $N$, quanta into the eye can do so only on the average, the actual number varying about $N$ with a standard deviation of $\sqrt{N}$. Thus, even if the subject invariably responded when 50 or more quanta entered the eye, a flash of nominally 40 quanta would sometimes contain 51 quanta and would be seen, whereas one of nominally 60 quanta would sometimes contain only 49 quanta and would be missed.

But quantum fluctuations on 50 quanta are too small to explain the whole of the scatter evidenced in the experimental S-shaped curves, and there seemed no satisfactory way of separating quantum from biological fluctuations. Recently a big step forward was made by Hecht, Shlaer and Pirenne[4], who advanced strong reasons for thinking that quantum fluctuations are the main factor. They made new determinations of the threshold under the optimum conditions indicated above and obtained values ranging from 54 to 148 quanta for seven observers. They estimate that, of the light incident on the cornea, only about half reaches the retina, the other half being lost by absorption, reflexion or scattering in the optic media of the eye. The crux of their argument is, now, that of the light reaching the retina, at most 20 per cent is actually absorbed by the visual purple, the light-sensitive substance in the retinal rods, which are certainly the end-organs by which the stimulus is seen under the conditions of the threshold measurements. They arrived at the figure of 20 per cent from estimates of the total quantity of visual purple in the retina and from a comparison of the spectral absorption curve of visual purple with the scotopic visibility curve. They conclude that the threshold increment of 54–148 quanta measured outside the eye corresponds to an absorption of at most 5–14 quanta in the retinal rods, and these latter numbers are the ones on which the quantum fluctuations must be assessed. Assuming that the absorption of $n$ quanta (or more) will always produce a visual response, the S-shaped curve can be calculated from the Poisson probability formula for any value of $n$. Hecht, Shlaer and Pirenne found that their experimental S-shaped curves fitted the calculated curves for values of $n$ ranging from 5 to 7 (see Fig. 1). The agreement with the upper limit of 5–14 quanta, derived from the absolute value of the threshold, is remarkably close, and these workers draw the conclusion that quantum fluctuations of the stimulus are the main cause of the indefiniteness of the absolute threshold of vision.

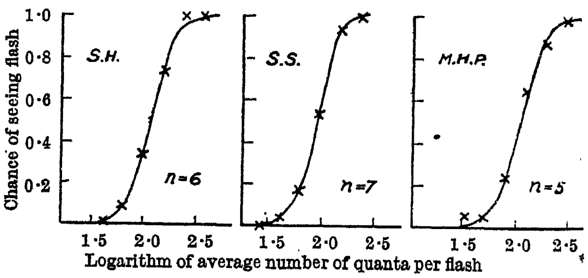


Fig. 1. RELATION BETWEEN THE CHANCE OF SEEING THE STIMULUS AND THE NOMINAL INTENSITY OF THE STIMULUS. THE PLOTTED POINTS ARE THE EXPERIMENTAL VALUES: THE CURVES ARE CALCULATED FROM THE POISSON DISTRIBUTION ASSUMING THE EFFECTIVE NUMBER OF QUANTA IN THE VISUAL ACT TO BE 6, 7 AND 5 FOR THE RESPECTIVE OBSERVERS. (FROM HECHT, SHLAER AND PIRENNE[4].)

The conclusion applies in the first instance to monochromatic green light (510 $m\mu$), the radiation to which the dark-adapted eye is most sensitive, but it is probably equally valid for other wave-lengths. For these other colours, although the number of quanta in the threshold flash outside the eye may be many thousands, the number actually absorbed in the rods and thereby participating in the visual act is reduced to the same value as for green light by the smaller absorption of the visual purple. It is also possible that when the retina is adapted to brightness levels above zero, the scatter of measurements of the threshold increment is still mainly determined by quantum fluctuations.

The S-shaped curve has a bearing on another interesting visual question—the problem of summa-

* Abridged from a lecture before the Physical Society delivered on May 24.

tion. If two or more similar patches of light are sufficiently close together in a dark field of view, they are visible at a lower brightness than a single patch. If the patches are small, say, 0·1° in diameter, and contained in an area of about 1° diameter, the threshold brightness for ten patches is about one tenth that for one. This is an example of physiological summation. The patches assist each other by some retinal interaction which has a very limited radius of action. If the patches are widely separated, however, a kind of summation is to be expected merely as a result of the scatter of the threshold evidenced in the S-shaped curve. If for a given patch brightness the chance of seeing a single patch is $p$, the chance $P$ of detecting a group of $n$ patches is the chance of not missing every patch, or $1-(1-p)^n$. This is provided the chance of seeing a given patch is independent of the presence or absence of the other patches. From an experimental S-shaped curve for $p$, the corresponding curve for $P$ can be calculated from the formula just given, for any value of $n$, and the relative thresholds for the single patch and the group can be determined. Meatham and Lambert[5] discuss this point in their work on the visibilities of groups of light patches seen against a starlight background, and from their S-shaped curve for $p$ they calculate that four patches would reduce the threshold brightness by a factor of 0·85, and that for a very large number of patches the reduction factor would be about 0·6.

Summation of this kind may be called probability summation, to distinguish it from physiological summation, which occurs in the retina or other more peripheral parts of the response process. Its operation does not depend on the cause of the scatter evidenced in the S-shaped curve, which may be either quantum or biological fluctuations or some resultant of the two.

Pirenne[6] has independently applied a similar idea to binocular summation in the perception of a point flash by the dark-adapted eye.

## Visibility Curves under Different Conditions

Recently visibility curves for both fovea and parafovea have been determined by the brightness matching method, using a sufficiently small matching field for the retinal properties within it to be fairly constant. In this work of Walters and Wright[7], measurements were made from near threshold up to quite high brightnesses of the matching field, and the gradual change in the form of the parafoveal visibility curve from a typical rod curve with maximum at about 510 mμ to a typical cone curve with maximum at about 560 mμ was established. At the lowest brightnesses used, the form of the visibility curve in the red end was still changing, indicating that the cones were still having some effect.

It is of interest to try to interpret the changes in the parafoveal visibility curve, using the picture of the rod-cone transition which is presented by measurements of the threshold. The change in the parafoveal threshold as the brightness level is raised follows a curve such as that shown in Fig. 2, which refers to a green adapting brightness and a yellow test stimulus. There is no reasonable doubt about the meaning of this curve. The lower part represents the threshold of the rod mechanism, the upper part the threshold of the cone mechanism.

Experiment shows that if the wave-length of the test stimulus is changed, say from 580 to 500 mμ,

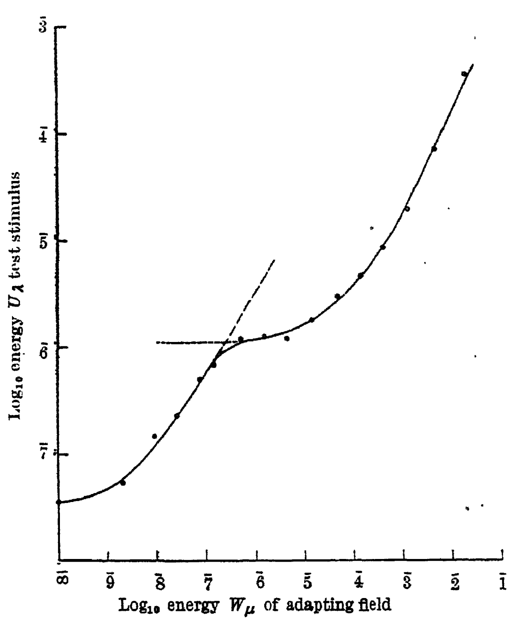


Fig. 2. 5° PARAFOVEAL THRESHOLD FOR A TEST STIMULUS OF WAVE-LENGTH 580 mμ AND AN ADAPTING FIELD OF WAVE-LENGTH 500 mμ. (FROM STILES[8].)

the rod component curve is moved bodily down to lower energy thresholds because the rods are more sensitive to light of wave-length 500 mμ. The cones, however, are less sensitive to this wave-length and the cone curve moves up. Change in the wave-length of the adapting field produces similar bodily shifts of the component curves, but parallel to the horizontal axis.

By a reasonable generalization of these experimental results[8] the condition that the two halves of a photometric field, viewed parafoveally, shall be on the threshold of discrimination is obtained in the form:

$$1 = \left[\frac{\delta\sigma}{F_s(\sigma)}\right]^2 + \left[\frac{\delta\pi}{F_p(\pi)}\right]^2 \quad . \; . \; . \; (1)$$

where $\sigma$ and $\sigma + \delta\sigma$ are the scotopic values, and $\pi$ and $\pi + \delta\pi$ are the photopic values of the lights in the two halves of the field. The scotopic and photopic values of a light of energy distribution $W_\lambda d\lambda$ are defined as $\sigma = \int W_\lambda s_\lambda d\lambda$ and $\pi = \int W_\lambda p_\lambda d\lambda$, where $s_\lambda$ and $p_\lambda$ are respectively the spectral sensitivity curves of the rod and cone mechanisms. The fixed functions $F_s(x)$ and $F_p(x)$ are determined by the shapes of the rod and cone component curves of Fig. 2. By applying a method due originally to Helmholtz[9] the threshold condition (1) can be used to derive a step-by-step visibility curve for any intensity level of the matching field. Curves calculated in this way are compared with a selection of Walters and Wright's experimental curves in Fig. 3.

As the brightness level is raised, both the observed and theoretical curves[10] show initially a rise in the red and later a shift of the maximum towards the red, and the intensities at which these changes occur are in fair agreement. It should be observed, however, that the step-by-step method was not used by Walters and Wright; they used a fixed red comparison field. At high brightnesses, the step-by-step and the fixed comparison field visibility curves are substantially the same, but this may not be so in the transitional

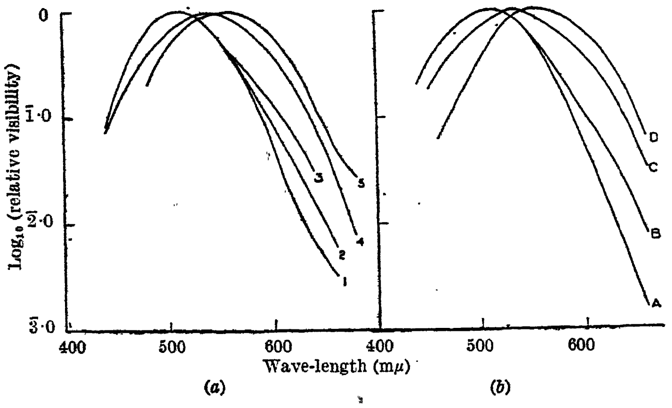


Fig. 3. BRIGHTNESS MATCHING IN 3° PARAFOVEAL REGION.
(a) Experimental curves (Walters and Wright)
$W_{630}$ = Energy intensity at 630 m$\mu$
= $3 \cdot 8 \times 10^{-6}$ ergs/deg.$^2$/sec. (Curve 1)
= 6·2 ,, ,, ,, (Curve 2)
= 9·2 ,, ,, ,, (Curve 3)
= 37 ,, ,, ,, (Curve 4)
= 230 ,, ,, ,, (Curve 5)
(b) A, mean scotopic visibility curve[10]
B, computed curve, $W_{630} = 11 \times 10^{-6}$
C, ,, ,, $W_{630} = 29 \times 10^{-6}$
D, mean photopic visibility curve

region. Nevertheless, this tentative application of the Helmholtz method suggests that it may prove of use in interpreting on a common basis the threshold and brightness matching results.

The Helmholtz method of deriving a step-by-step visibility curve from threshold measurements can also be applied to foveal vision. Here, instead of two mechanisms, rods and cones, there are three mechanisms to consider, the three kinds of cone. The threshold condition takes the form:

$$1 = \left[\frac{\delta x}{F_r(x)}\right]^2 + \left[\frac{\delta y}{F_g(y)}\right]^2 + \left[\frac{\delta z}{F_b(z)}\right]^2, \quad . \; . \; . \; (2)$$

where $x = \int W_\lambda r_\lambda d\lambda$, $y = \int W_\lambda g_\lambda d\lambda$, $z = \int W_\lambda b_\lambda d\lambda$ and $r_\lambda$, $g_\lambda$, $b_\lambda$ are the spectral sensitivity curves of the three cone mechanisms. These curves and the fixed functions $F_r(x)$, $F_g(x)$, $F_b(x)$ have all been determined to a first approximation from measurements of foveal thresholds. The derived visibility curves, (a) for very high field brightness, (b) for a brightness at the level normally used in photometry, are shown as the plotted points in Fig. 4. The agreement with the C.I.E. visibility curve is promising.

The colour perceptions in the parafoveal retina are not radically different from those in the fovea, and it must be assumed that there, too, three cone mechanisms are operative. The discussion of the parafoveal visibility curve should therefore have been based on a four-dimensional threshold condition:

$$1 = \left[\frac{\delta\sigma}{F_s(\sigma)}\right]^2 + \left[\frac{\delta x}{F_r(x)}\right]^2 + \left[\frac{\delta y}{F_y(y)}\right]^2 + \left[\frac{\delta z}{F_z(z)}\right]^2 \; . \; . \; (3)$$

It is not difficult to see, however, that the resulting visibility curves would not be materially different from those obtained on the simpler view. But the form of the result raises a difficult question in our ideas of the visual mechanism. At the fovea, the two halves of the field will match in all respects if $\delta x$, $\delta y$ and $\delta z$ are small, that is, if three relations of the form $\int r_\lambda W_\lambda d\lambda = \int r_\lambda W_\lambda' d\lambda$ approx. are satisfied. In the parafovea it appears that four such relations would have to be satisfied, which apparently contradicts the main tenet of the trichromatic theory.

Psychologists, in particular Katz[11], have emphasized that hue, saturation and brightness are not the only modes of appearance of colours. It is conceivable that another modality, for example, a 'filminess-solidity' differentiation, might be manifest in parafoveal vision, and that to equate parafoveal fields in this respect, as well as in hue, saturation and brightness, a fourth variable would be required. However this may be, the immediate requirement for an attack on this interesting visual problem is a thorough investigation of colour-matching in the parafovea.

## The Retina in a State of Change

Wright[12] has shown that information about the relative rates of recovery of the different cone mechanisms can be obtained by the method of binocular colour matching. The test light seen by the recovering eye is colour-matched by a mixture of three spectral primaries forming the comparison light seen by the control eye. As recovery proceeds, the varying amounts of the primaries required determine three recovery curves. One of the first problems attacked by Wright was the determination of the visibility curves of the three cone mechanisms, or the fundamental response curves. The underlying assumption was the so-called law of coefficients. This says that if $x$, $y$, $z$ are the quantities of the fundamental primaries (that is, hypothetical primaries each of which stimulates only one of the cone mechanisms) which match the test light before the application of the adapting light, then at a given time $t$ after removing the adapting light the quantities required will be $ax$, $by$, $cz$, where the coefficients $a$, $b$, $c$ are independent of the intensity and colour of the test light. They will, of course, depend on the characteristics of the adapting light and the time $t$. By experimenting with various test lights and adapting lights, Wright was able to derive a set of fundamental response curves which were consistent with the results and with the coefficient law. These seemed satisfactory except for the fact that the green response curve dropped to negative values in the blue end of the spectrum. Although negative values are quite acceptable in colorimetry, they cannot easily be interpreted as a property of a cone mechanism. Recently Walters[13] has shown that the coefficient law is not true in general, and has suggested that it becomes true only in the limiting case of a test stimulus of very low intensity. On this view, he has made a re-determination of the red and green response curves.

The coefficient law may fail because the test light itself is sufficiently bright to modify the recovery process, and this modification may occur to different extents for the three mechanisms. This would not necessarily entail any interaction between the three mechanisms. However, there is evidence of true interaction between the mechanisms. A specially noteworthy effect is the phenomenon of the positive blue[13,14]. If the retina is adapted with a strong red light and a red test light is applied, then within the first few seconds of recovery the test stimulus appears desaturated or possibly purplish, and positive blue has to be introduced into the comparison patch. It might be expected that the red adapting light would

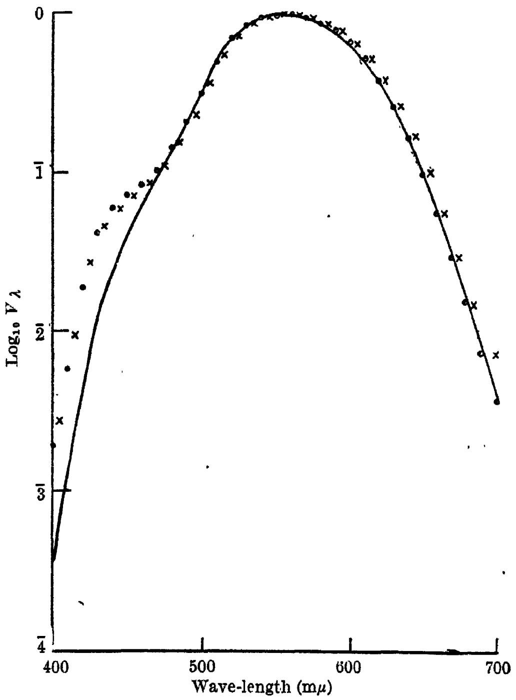


Fig. 4. FOVEAL VISIBILITY CURVE.
⊙, derived by threshold method: very high brightness;
×, derived by threshold method: photometric brightness level (80 photons);
Continuous curve: C.I.E. visibility curve.

fatigue the blue mechanism less than the red or green, but then the red test stimulus would also stimulate the blue mechanism less. The evidence now accumulated seems to rule out any explanation of the positive blue on the basis of three independent mechanisms with constant spectral response curves. It should be noted that the effect cannot be attributed to a blue after-image superposed on, but otherwise independent of, the test light, for it can occur under conditions where no blue after-image is visible in the absence of the test light.

Another type of interaction occurs if the rate of recovery of, say, the green mechanism depends on the instantaneous conditions or on the rates of recovery of the other two mechanisms. Such interaction might not of itself entail a breakdown in the coefficient law. That interaction of the kind in question does occur has been shown by Wright[14], who found that the red and green recovery curves followed different courses depending on whether, in the initial adaptation, the blue mechanism was, or was not, highly stimulated. It is not difficult to conceive how interaction of this type could be brought about if the recovery of the three mechanisms depended on some common and limited reservoir of photochemical material or on some common recuperative substance, such as oxygen carried by the blood.

On the whole, it seems that the notion of three independent cone mechanisms with fixed response curves works fairly well provided the retina has become adapted to the radiation falling on it. It is in the process of changing from one state of adaptation to another that the effects of interaction are chiefly exhibited.

## Fundamental Response Curves

König believed that the principal colour blinds—protanopes, deuteranopes, tritanopes—differed from the normal simply by the lack of one of the three response mechanisms, and his proposed fundamental response curves—*Grundempfindungen*—were chosen largely to fit in with this idea. New measurements by Pitt[15] of the colour-mixture curves, the visibility curve and the hue discrimination of protanopes and deuteranopes, and a reconsideration by him of König's observations on five tritanopes, lead him to the following conclusions. Protanopes lack the red mechanism, tritanopes the blue mechanism, while deuteranopes have in place, of the red and green mechanisms a single mechanism the response curve of which is a weighted mean of the normal red and green curves. His fundamental response curves based on this view and on some other evidence are of the same general type as König's as regards position of the maxima and shape. They are also in tolerably good agreement, in these two respects, with the spectral sensitivity curves of the three cone mechanisms derived from measurements of foveal thresholds. Walters' red and green response curves obtained from binocular matching are consistent with Pitt's curves. It seems that there is an accumulation of evidence obtained in different ways in favour of a set of curves of the König type.

Of recent years a great many measurements have been made, both in Great Britain by Wright[16,17] and his co-workers and in the United States by MacAdam[18], on the hue limen and the more general colour limen throughout the colour triangle. The results have been expressed in terms of the C.I.E. trichromatic system and the so-called uniform chromaticity system. Presumably, if expressed in terms of the fundamental primaries, they would assume a particularly significant form. This does not mean that when so expressed they would exhibit any very obvious or simple property. In particular, they will not show that, in the triangle or in the rectangular system, just distinguishable colours are always separated by a fixed distance. It now seems certain that no linear transformation of the C.I.E. co-ordinates would present the limen measurements in this simple form. The analysis of the data is complicated by the existence of considerable differences between the results of different observers. By the use of *non-linear* transformations of the C.I.E. co-ordinates, Moon and Spencer[19] have succeeded in expressing the complete liminal data of one observer in the much desired form in which a fixed distance in the diagram separates all pairs of just distinguishable colours. The physical implications of this result are not yet clear.


[1] Barnes, A. B., and Czerny, M., *Z. Phys.*, **79**, 436 (1932).
[2] Stiles, W. S., *Rept., Phys. and Opt. Soc.*, 326 (1932), "Discussion on Vision".
[3] Brumberg, E., and Vavilov, S., *Bull. Acad. Sci. U.R.S.S.*, 919 (1933).
[4] Hecht, S., Shlaer, S., and Pirenne, M. H., *J. Gen. Physiol.*, **25**, 819 (1942).
[5] Meetham, A. R., and Lambert, G. E. V., Report to Ministry of Home Security (unpublished) (1942).
[6] Pirenne, M. H., *Nature*, **152**, 698 (1943).
[7] Walters, H. V., and Wright, W. D., *Proc. Roy. Soc.*, B, **131**, 340 (1943).
[8] Stiles, W. S., *Proc. Roy. Soc.*, B, **127**, 64 (1939).
[9] Helmholtz, H. von, "Handb. Physiol. Optik" (2nd Edit., 1896), 448.
[10] Stiles, W. S., and Smith, T., *Proc. Phys. Soc.*, **56**, 251 (1944).
[11] Katz, D., "The World of Colour" (London: Kegan Paul).
[12] Wright, W. D., *Proc. Roy. Soc.*, B, **115**, 49 (1934).
[13] Walters, H. V., *Proc. Roy. Soc.*, B, **131**, 27 (1942).
[14] Wright, W. D., *Proc. Roy. Soc.*, B, **122**, 220 (1937).
[15] Pitt, F. H. G., *Proc. Roy. Soc.*, B, **132**, 101 (1944).
[16] Wright, W. D., and Pitt, F. H. G., *Proc. Phys. Soc.*, **47**, 205 (1935).
[17] Wright, W. D., *Proc. Phys. Soc.*, **53**, 93 (1941).
[18] MacAdam, D. L., *J. Opt. Soc. Amer.*, **32**, 247 (1942).
[19] Moon, P., and Spencer, D. E., *J. Opt. Soc. Amer.*, **33**, 260 (1943).

# JOHN TORREY: AMERICAN BOTANIST

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TO those familiar with the vast and productive western and middle-western regions of the United States, the realization may come as something of a shock that these spacious lands were not only little developed but also very little known a century ago. A recent book* embraces that very important phase of American history—the detailed exploration and development of the West. In it we learn much of the coming and going of expeditions, of the trials of explorers and administrators, and of the discovery of all manner of new features. The West was still a country where exploration in the full geographical sense could be carried out—in contrast to the world to-day which, to be honest, we must admit contains few if any major areas remaining to be discovered or even primarily surveyed—and it was still very much a land of wild Indians and all manner of dangers both known and unforeseen. Much the same was true, in lesser degree, of the Rocky Mountains and many tracts lying nearer to the eastern and southern fringes of civilization.

But the very period of these explorations (well on in the nineteenth century) was one of great scientific awakening and development; and so, fortunately, they saw a telescoping of geographical exposition with the scientific investigation which is the real and none the less fascinating work of the explorer of to-day.

Accordingly to the subject of this biography, the expeditions brought in plant collections in considerable number and variety, which led to his being the first to describe the flora of many areas that had previously remained unknown botanically. At first the recognition of the calls of botany needed activating by the instruction and dispatch of collectors; but in time it seemed to proceed almost automatically. Indeed, the reader might be excused if, in a fit of enthusiasm, he were to conclude that this account of the botanical investigation which proceeded in the United States in the days of John Torrey gave a very fair picture also of the history of American exploration in those momentous times.

Torrey the botanist was born in 1796 in New York, of a New England father of British ancestry, and died early in 1873 in his seventy-seventh year. Though a physician by training and to a considerable extent a chemist by profession, he was practically always a botanist by choice. Botany it was that brought him fame, and, through him, made great the name. His long and active life encompassed those of many famous botanists, whom he helped and encouraged in his own country and corresponded with in other parts of the world—so that the story of his work and times is punctuated with their names and contains long extracts from their correspondence.

We learn much of Amos Eaton, "the first great teacher of natural history in America"; of the scholarly mycologist Schweinitz (a prominent clergyman like the pioneering G. H. E. Muhlenberg, "the father of American botany"); of Nuttall, whom Sir William Hooker termed "a queer fellow" though admitting that "he certainly does contrive to get access to most interesting plants"; of the Hookers themselves, both father and son; of David Douglas and Thomas Drummond; of Major Emory and Colonel Frémont, who frequently botanized instead of fighting; of William Darlington and Chester Dewey the caricologist; of D. C. Eaton, of Yale; of the admirable Engelmann, who for a while practised medicine, but then found the lure of botanical researches irresistible; of Tuckerman the lichenologist and Sullivant the bryologist; of the Bigelows and various LeContes; of John Lindley, of whose "Natural System" Torrey published an American edition in 1831; of C. C. Parry, who brought such distinction to western botany, though he was "one of the quietest men in the world—he *pokes* about and turns over any collection of plants that may be lying about" (according to Torrey, who appeared to agree that this was a good beginning for a botanist); of M. C. Leavenworth and Charles Wilkins Short; of Frederick Pursh, whom Torrey disliked as a man and (as is unfortunately common especially in a youthful civilization) accordingly underestimated as a botanist; of Edwin James, of Long's famous expedition in the Rocky Mountains; of Sir John Richardson and the peculiar Rafinesque; and, most notable of all, of the great Asa Gray, whose chief teacher and 'spiritual father' Torrey clearly was. We also learn much of the American learned societies of that day and this—including the Smithsonian Institution, the American Philosophical Society, the National Academy of Sciences at Washington, D.C., and the Lyceum of Natural History of New York with its successor the New York Academy of Sciences.

The author of Torrey's biography has obviously been at great pains to rout out all manner of data and evidence, both published and unpublished. Nevertheless the resulting publication is not without blemishes—as, for example, a fair quota of misprints and ambiguities, the rather loose literary style and apparent lack of expert editing, and the inclusion of such a welter of fact and seemingly minor detail that the result is at times confusing. Moreover, where so much space is given to the description of expeditions and the routes they took, it is surprising not to find more maps. The characters are also very numerous, coming and going so that the central one is apt to be swamped, and no very clear picture of John Torrey, the man, emerges. However, we are given here and there tantalizing glimpses of the real and rather lovable human being—as, for example, in extracts from his personal letters and in the anecdote about the child John who "considered it a great hardship to be sent after dark into the country . . ." although by day he loved the wild tracts beyond the small heart of contemporary New York.

In short, the book is not easy reading; but the theme is intensely interesting. For Torrey lived in one of the most vigorous phases of American history, a history which is seen in this biography from a new or at least unhackneyed angle—that of a pioneer in taxonomic and phytogeographical research whose experiences should prove valuable to students, botanical or otherwise, of the period or of that noble and fundamental science. For fundamental it is, in that taxonomy (most profitably with the background of its geographical offshoot) deals with the delimitation and identification, and where necessary the description and classification, of biological entities of

* John Torrey: a Story of North American Botany. By Andrew Denny Rodgers, III. Pp. x+352. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1942.) 3.75 dollars or 25s. net.

innumerable sorts and sizes, and little enough botanical or zoological or other connected scientific work of a lasting nature can be accomplished without proper knowledge of what the entities concerned are.

Torrey's botanical publications began in his early twenties and extended, as those of so many devoted botanists have done, over more than half a century and until past the time of his death. In size and importance his papers and books grew through the first volume of his "Flora of the Northern and Middle Sections of the United States" (1824), then his monumental two-volume "Flora of the State of New York" (1843) and his joint work with Asa Gray on the "Flora of North America" (1838–43), which was the most searching and authoritative treatment of North American plants up to that time. Most of the expedition reports followed, though often in intervals between work at other subjects.

Torrey lived in the days when, at least in the New World, a man of science could easily be a 'professor' (the title often meaning less in America than in Europe) of different subjects at different times, or even of different subjects at the same time; and in fact Torrey was, as a young man, professor of chemistry and mineralogy at West Point, and later for many years professor of chemistry at Princeton and at the same time professor of botany and chemistry at the College of Physicians and Surgeons of New York (part of what is now Columbia University), where he had graduated. As a chemist he appears to have discovered pectin, which he called "sclerotin", while his chemical knowledge and ability received high recognition later in life when he was made United States assayer; but always he was in touch with, and usually he had a hand in, anything of importance, botanically speaking, which was going on in that rapidly developing country.

As a man Torrey was predominantly straightforward and hard-working, clearly owing his deserved and lasting fame to the consistent expression of these qualities through a life-long devotion to his favourite subject. He appears during his life-time to have been highly respected and widely loved. In the words of one of the most eminent of his successors in the modern practice of taxonomy, Prof. M. L. Fernald, of Harvard, "Torrey was exact, scholarly, a kindly and devoutly religious man, and in the goodness of his heart ready to help everyone". I have heard Prof. Fernald refer to Torrey's descriptions of plants as "wonderfully vivid and accurate, models to this day" —high praise indeed from the director of the Gray Herbarium, whose great founder was Torrey's pupil, assistant and then associate over a total span of more than forty years.

Gray himself styled Torrey "an investigator . . . characterized by a scrupulous accuracy, a remarkable fertility of mind, especially as shown in devising ways and means of research, and perhaps by some excess of caution", who had a "thorough love of truth for its own sake" and "took a prominent part down almost to the last days of his life" in putting into order and describing the materials coming in almost interminably from the exploring expeditions of the time. All this appeared to result from the circumstance that, as a boy, Torrey had been taught by Amos Eaton "the structure of flowers and the rudiments of botany" when Eaton was serving a term in the New York State prison, of which Torrey's father, Alderman William Torrey, was then fiscal agent. Eaton seems to have taught in such a way as to 'awaken a taste and kindle a zeal that could be extinguished only with the pupil's life'. How much greater in our scientifically enlightened days are the data and chances of the educator, and how vitally important his task!

The effect which Torrey has had on botanical knowledge and institutions in America can scarcely be over-emphasized. His name is commemorated in a 'unique' genus of the Coniferæ, in numerous species of vascular plants, in a noble peak in the Rocky Mountains, and in the splendid Torrey Botanical Club; his herbarium exertions "representing a deal of back-ache" went far towards starting two of the greatest herbaria of the world, namely, the United States National Herbarium and the Herbarium of the New York Botanical Garden. Essentially an *American* botanist, finding more than enough to do within the confines of his own sub-continent, Torrey was content to describe rather than to classify, to investigate rather than to theorize—wisely leaving to others, whom he knew would come, the generalization for which he realized the time to be unripe.

Although essentially a practical man, Torrey was to a considerable extent a 'cabinet' botanist, though living in the days when such were needed. He did not experience the thrills and adventures of the actual explorers whose results he worked out so tirelessly and meticulously. His were rather the thrills and adventures of research—the excitement of the microscope and of testing the validity of speculations—the joys which strict compliance with the requisites of minute analysis may bring: for his was the imagination which can see a verdant treasure in a dried specimen. He had the all-important taxonomist's flair; and had he lived in these days of cytogenetics and physecology there can be little doubt that he would have backed or underlain this flair with far more field observation. As things were, however, he was hard put to it, in the midst of other and often more lucrative duties, to arrange and assort, then diagnose, name and describe, the new things which came to him almost daily. There is something of greatness in the man who can sit and wait and have all that he wants come to him; and in the aggregate Torrey must have named and described some thousands of new species and varieties of plants.

In most modern countries, as in the United States of America, botany is a great subject with a vast following both professional and lay—especially among the enlightened who realize that it is by plants that man is largely surrounded, and on them that he lives—consequently its study is imbued with sentiment and historical flavour. In deference to this we may appropriately conclude the present account by quoting Asa Gray, who thus closed his obituary notice of Torrey's life: "Thirty or forty years ago, a new and remarkable evergreen tree was discovered in our own Southern States, which it was at once determined should bear Dr. Torrey's name. More recently a congener was found in the noble forests of California. Another species had already been recognized in Japan, and lately a fourth in the mountains of Northern China. All four of them have been introduced and are greatly prized as ornamental trees in Europe. So that, all round the world, *Torreya taxifolia*, *Torreya Californica*, *Torreya nucifera*, and *Torreya grandis*—as well as his own important contributions to botany, of which they are a memorial—should keep our associate's memory as green as their own perpetual verdure".

# OBITUARIES

## Brevet-Colonel F. Percival Mackie, C.S.I., O.B.E.

BREVET-COLONEL MACKIE, who had a distinguished career in the Indian Medical Service, died at Oransay, Birnam, on July 15. At the time of his death he was chief medical officer to the British Overseas Airways Corporation in London. He leaves a widow and three sons.

Born on February 19, 1875, son of the Rev. John Mackie, rector of Fylton, Glos, he was educated at Dean Close School, Cheltenham, the University of Bristol, and St. Bartholomew's Hospital. After graduating in medicine and surgery at the University of London he entered the Indian Medical Service in 1902, taking first place in the competitive examination of that year and winning the Gold Medal in medicine and the scholarship in surgery. Later in his career he added the F.R.C.P. and the F.R.C.S. as well as the D.P.H. to his professional qualifications.

In India, after a short period of military duty which included a tour as medical officer to the Younghusband Mission to Tibet, he elected for the civil side of the Service with the object of devoting himself to bacteriology and medical research, for which, at that time, organized arrangements in India were in an early stage of development. It was the time when the terrible drama that was being played by malaria, cholera and plague had confirmed the Government of India in its intention to establish an effective organization of bacteriological workers and laboratories, and when several outstanding discoveries in tropical medicine had inspired and stimulated qualified members of the Service to engage in one or other of the young sciences (particularly bacteriology, protozoology and medical entomology) which offered a prospect of finding effective means of control and prevention. Plague, which had appeared in Bombay in 1896, was still spreading eastwards and northwards throughout the country, and Mackie's first appointment in the newly created Bacteriological Department of the Government of India (which was afterwards known as the Medical Research Department) was to the Plague Research Laboratory, Parel, Bombay. This was in 1905, the year in which the British Plague Commission under Dr. C. F. Martin, director of the Lister Institute, arrived in India and selected the Parel laboratory as its headquarters. In this appointment Mackie shared in the brilliant work of the Commission which, as is well known, settled the question of rat-flea transmission and gave to India, and the world in general, fundamental knowledge of the epidemiology of plague to which little was added in later years.

From September 1908 until November 1909 Mackie was on deputation to Uganda as a member of the Royal Society's third Sleeping Sickness Commission under Sir David Bruce. On his return to India he again took up his post at Bombay.

In 1911 the Government of India deputed him for special research again, this time to study kala azar in Assam. The causal organism of this fatal disease (the Leishman-Donovan parasite) had been discovered a decade earlier; but the mode of transmission was still unknown. It was suspected generally that the transmitting agent must be an insect, but prolonged research with bed-bugs, mosquitoes, fleas, lice and ticks had yielded no convincing result. Mackie and others had observed a significant correspondence between the topographical distribution of cases of kala azar and of a particular species of sandfly, and he made an important contribution when he said in his report: "The only insect which has given any return for the work put into it is the sandfly, and I am of opinion that the relation of this insect to the disease would repay further investigation". Fourteen years later the correctness of this opinion was confirmed when intensive team-work by the staff of the Calcutta School of Tropical Medicine, supplemented by that of the Government of India's special Kala Azar Commission, convincingly incriminated the sandfly as the true vector.

Among much other outstanding work there is space to mention only the speedy and efficient manner in which Mackie, working under great difficulties of supply, established a central bacteriological laboratory in Mesopotamia in 1916 and thus ensured the prompt bacteriological diagnosis of cholera and other epidemic diseases which broke out among British troops on their way up the Tigris River to relieve Kut. The strain of the cholera vibrio which he isolated from a colleague who fell a victim to the disease was afterwards maintained as the type of the organism endemic in that part of the world. For his services in that War he was twice mentioned in dispatches and the honour of O.B.E. was conferred upon him.

After the War Mackie held in succession the posts of professor of pathology in the University of Calcutta, director of the Pasteur Institute, Assam, and director of the Haffkine Institute, Bombay. Later he officiated for a year as public health commissioner with the Government of India and for another year as surgeon general with the Government of Bombay. While holding these administrative offices he was honorary surgeon to the King and to the Viceroy. The C.S.I. was conferred upon him in 1932.

S. P. JAMES.

## Mrs. E. J. Hatfield

MANY will have learned with regret of the death of Mrs. Hatfield in early June. Those who knew her will realize that she never spared herself; after retirement she took up part-time work for the British Social Hygiene Council.

During her earlier years she studied in the University of London and at Cambridge. Some of her student years were also spent in Germany. Possessed of an open mind, she later evinced much interest in biology and psychology and followed carefully the trend of modern biological research. At the North London Collegiate School, a great many pupils passed through her classes, and all will testify to the thoroughness of her training and to the inspiration for sound work which she inculcated. While teaching, she published the well-known text-book "An Introduction to Biology".

After her retirement from teaching Mrs. Hatfield lectured for a time at one of the training colleges. At the summer schools and conferences of the British Social Hygiene Council she will be remembered for her clearly delivered lectures and wise counsel. She played a most active part in the Association of Women Science Teachers and was always in demand as a speaker at the meetings of the Association. Her position on committees, consultative or otherwise, was recognition of the opinion in which she was held by her contemporaries.

Those of us who knew Mrs. Hatfield as a friend learned to value her pleasant personality and ready smile. One could not be in her company for long without realizing her capabilities and wide cultural interests. Her outstanding characteristic was courage —the keynote of her life. Her friends and colleagues will miss very much one who possessed a fund of knowledge and a balanced outlook on life.

P. M. TAYLOR.

WE regret to announce the following deaths:

Sir Arthur Hurst, president during 1927–29 of the Section of Medicine of the Royal Society of Medicine, on August 17, aged sixty-five.

Prof. S. P. Mercer, professor of agricultural botany in the Queen's University, Belfast, and senior technical research officer of the Ministry of Agriculture, Northern Ireland, aged fifty-three.

# NEWS and VIEWS

## Agriculture at Edinburgh

THE endowment of the chair of agriculture in the University of Edinburgh was presented in 1790 by Sir William Pulteney, Bt., M.P., as a mark of his appreciation of his old University. Agriculture thus became the first chair in Edinburgh to be founded by a private benefactor, for its twenty-three predecessors had all been instituted either by the Crown or by the Town Council of Edinburgh, and it is probably the earliest foundation of its kind in any university in Britain. The present occupant of the chair, Prof. Ernest Shearer, who is also principal of the Edinburgh and East of Scotland College of Agriculture, retires after eighteen years of service at the end of this session, and the electors have selected as his successor in both posts Dr. S. J. Watson, director-in-charge of the Jealott's Hill Agricultural Research Station of Imperial Chemical Industries, Ltd.

Dr. Watson was educated at Armstrong College, Newcastle-upon-Tyne, and his agricultural interests have covered a wide field. He has been associated with Imperial Chemical Industries at first as officer-in-charge of the Animal Nutrition and Biochemistry Section, and latterly as director of the Agricultural Research Station. At Jealott's Hill his experimental work is well known to agriculturists and to scientific workers, and he has made a recognized contribution to the knowledge and practice of farm methods. His books include "The Feeding of Cattle", "The Science and Practice of Conservation of Crops" and "Silage and Crop Preservation", and his published papers cover many subjects associated with the feeding values of different kinds of crops, processes of preserving crops by drying and silage methods, and the planning of cropping.

## Geophysics at Columbia University: Appointment of Prof. Maurice Ewing

PROF. MAURICE EWING, associate professor of physics at Lehigh University, has been appointed associate professor of geophysics in the Department of Geology of Columbia University. Prof. Ewing is at present engaged in research for the U.S. Navy with the civilian rank of chief scientist, and will take up his new post at the end of the War. At Columbia, Prof. Ewing will direct graduate instruction in geophysics as part of a post-war programme of geological training and research, and will continue his investigations of the continental shelf and the ocean basins. In recent years, through the development of special equipment of his own invention, Prof. Ewing has made geophysical measurements, both from ships on the surface and from submarines, of the continental margin beneath the ocean along the Atlantic coast of North America. Through these studies it was found in 1935–38 that the slope of the outwashed sediments off the Atlantic Coast did not conform to the slope of the underlying rock floor. In war-time the experience gained from these studies has been of special value to the U.S. Navy Department, and through the co-operation of the Government Prof. Ewing has been enabled to devote all his time to geophysical research, working from the Woods Hole Oceanographic Institute, at Woods Hole, Mass.

## Employment Policy and Technical Efficiency

SOME further points in regard to the White Paper on Employment Policy were elucidated in the debate in the House of Lords on July 5 and 6. Welcoming an inquiry from Lord Barnby, Lord Woolton stated that the Government proposed to take statutory powers in order to get the statistics required. On the question of cartels and international agreements raised both by Lord Trent and Lord McGowan, Lord Woolton indicated Government concurrence in the proposal that there should be a Government inquiry on restrictive practices, and urged that the question should be considered on a factual and not an emotional basis, and from the point of view of the public interest. As was independently pointed out by Lord Wardington, such agreements embody principles identical with those enunciated in the Atlantic Charter, which advocates international agreements and co-operation and the creation of spheres of interest. On the point of technical efficiency stressed by Viscount Samuel as the most important point in the White Paper, Lord Barnby, who also raised the question of the Government's views with regard to trade associations, urged that if industry is to have efficient equipment, it requires a revision of the Factory Acts to permit the two-day shift operation of female labour. Expensive new equipment must, to carry overheads, run more than eight hours in the twenty-four. Lord McGowan referred to the growing emergence in British industry of a new social outlook, and also asked for more guidance as to the basis on which future international commercial relations are to be built. The question of controls was repeatedly mentioned, and Lord Woolton's statement that the Government is already considering the steps by which we could have an orderly unwinding of the controls reflected the practical temper of this debate, which showed a deep sense of the fundamental importance of a high standard of efficiency in British industry and that the realization of the White Paper proposals would come, as Lord Woolton said, by steady evolution and the application of modern scientific methods.

## Science in the Universities

THE report "Science in the Universities" submitted by the Association of Scientific Workers to the University Grants Committee, March 1944, which has now been published, covers very little ground that has not already been dealt with by the reports from the Parliamentary and Scientific Committee, the Association of University Teachers, or the Nuffield College statements. It is limited to consideration of the physical and biological sciences and the applied sciences immediately related to them such as are normally taught in universities, with some attention to the social sciences; within these limits, it is one of the best guides that has appeared to the ways in which the rapid expansion of scientific knowledge and its application are affecting the universities, and to the measures required to deal with the immediate problems. Among the recommendations may be mentioned those stressing practical work in the vacations as part of the training of all scientific workers, not merely those training for industry; the emphasis on the education and training of laboratory technicians, and also on the technique of teaching.

The report supports the proposal for a universities academic council to co-ordinate the development of research, and also advocates research committees in each university to watch over the development of research, and administer the Government grant for research. Stress is also laid on the extension of maintenance grants, especially in post-graduate work, and the improvement of salaries and conditions of service. The report visualizes a doubling of the 1939 undergraduate population within four years after the War. The capital cost of the accommodation required, including a possible trebling of science departments, is estimated at not less than £30 millions over ten to twenty years, with an increase in annual expenditure to £15 millions within five years and to £20 millions after ten years. Doubling the Government grant in the first full academic post-war year, with an increase to £9 millions in the fifth year, is recommended.

## Standard Frequency Broadcasts

SOME slight modifications have recently been made in the radio transmissions of standard frequencies broadcast by the U.S. National Bureau of Standards from station WWV. A new radio frequency at 2·5 Mc./sec. now operates from 23.00 until 13.00 U.T.; and the time signals have been modified by the omission of the pulse on the 59th second of every minute. The service now comprises standard radio frequencies of 2·5, 5, 10 and 15 Mc./sec., at least three of which are available at any time; standard audio frequencies of 440 and 4,000 c./sec. broadcast on these carriers; and interruptions of these broadcasts which constitute accurate time signals synchronized with the basic time service of the U.S. Naval Observatory. The time signals, which are available throughout the 24 hours, consist of pulses of 0·005 sec. duration at intervals of 1 sec. on all the carrier frequencies, and of 1-min. interruptions of the modulating frequencies every 5 min. The seconds pulses are heard as faint ticks which provide useful standards of short time intervals for physical measurements as well as serving their main function as accurate time signals. On the 59th second of every minute the pulse is omitted.

The 1-min. interval in the audio-frequency transmission is used to give the station announcement, either in Morse or (at the hour and half-hour) orally, and it also permits use of the radio frequencies uncomplicated by the presence of the low frequencies. The accuracy of all the frequencies, radio and audio, as transmitted, is higher than 1 part in $10^7$. The intervals given by the seconds pulses are correct to $10^{-5}$ sec. The 1-min., 4-min. and 5-min. intervals marked by the interruption and resumption of the modulating frequencies are accurate to 1 part in $10^7$. The Astronomer Royal's annual report remarks of these broadcasts: "A remarkable degree of agreement has been noted in comparisons of both frequency and time; as a time signal, this form of transmission appears to be capable of a very high standard of precision and to be well adapted for accurate comparisons".

## International Trade

A BROADSHEET, "Facts about International Trade" (No. 219), issued by P E P (Political and Economic Planning), describes developments since the P E P report on international trade was published in 1937, and is intended to form the starting point for a later examination of some of the main problems of post-war international trade. The main conclusions emerging from the report itself and the present broadsheet are, first, that exports are essentially a means of obtaining necessary or desirable imports: neither Britain, the United States nor any other country should export primarily to create home employment; export and import policy should be deliberately related to a nation's balance of payments and to its long-term foreign lending and borrowing. Secondly, trade restrictions and bilateralism were a symptom more than a cause of the decline in world trade after 1929; post-war policy should aim at a continuing expansion of effective world demand, making full use of the world's man-power and resources. Multilateral trade, while creating the necessary conditions for obtaining the greatest possible advantages from international trade, also heightens the economic interdependence of nations. A restoration of multilateral trade requires: (*a*) an efficient international monetary exchange clearing system in which all nations have complete confidence; (*b*) the maintenance of full employment within national economies; (*c*) the maximum attainable measure of political security. These three requirements are essential to a universal 'economy of peace'. Failing the establishment of a universal multilateral system of trade, the 'low-tariff club' represents a means by which nations most dependent on international trade can secure the benefits of multilateralism on a limited scale. 'Lend-lease' is essentially a war-time method of international exchange and is unlikely to continue after the immediate post-war period of securities; but world prosperity, like peace, is indivisible. Finally, Great Britain's major problem in foreign trade after the War is to increase her visible exports very considerably, to repair the inroads of war here and in overseas investment income, and to maintain the volume of imports vital to her standard of living.

## Soviet Academy of Sciences in Western Siberia

IT is announced in the *Soviet War News* that a new branch of the Soviet Academy of Sciences has been opened in western Siberia to direct scientific activities in the territory stretching from the Ural Mountains to the banks of the Yenisei, and from the Arctic coast to China and Central Asia. It is believed that

a promising future exists there for agriculture, forestry, fishing and coal mining; and there are large deposits of metals and raw materials for the chemical industry. Long before the outbreak of war, the Soviet Government had made detailed plans for the development of Western Siberia; the War has given a great impetus to the process of industrialization. Many of the factories, colleges and scientific research institutions evacuated to the territory from the danger zones have already returned to their homes, but not without leaving behind important traces of their activities, as well as a proportion of their staffs to continue the work begun in Siberia.

The West Siberian branch of the Academy incorporates the Mining, Engineering and Geology Institute, the Chemico-Metallurgical Institute, the Power and Transport Institute and the Medical and Biological Institute; Novosibirsk has been chosen as its seat; and it will also have offices in Tomsk and Omsk, as well as in the new industrial towns which have sprung up during the last twenty-five years. Typical of these are Kemerovo (chemical and coal industry), Prokopievsk (coal), Stalinsk (metallurgical industry and mining) and Barnaul (centre of the Altai region). Prof. A. Skochinsky, a specialist in mining engineering, is head of the newly formed branch.

## British Film Institute Summer School

A COURSE on visual education was organized by the British Film Institute at Bangor during August 19–26. Among a wide range of topics discussed, very useful contributions were made by Mr. Geoffrey Bell of the Shell Film Unit who discussed "The Scientific Film" and Mr. Neilson Baxter, of the same Unit, who dealt with "The Documentary Film". Both argued that the scientific, realist approach to a subject so characteristic of the documentary group of film-makers is in essence also the proper characteristic of an educational classroom film, as well as being useful for enlarging the child's general knowledge of his environment. Other speakers were Mr. G. P. Meredith, lecturer in visual education at the University College of the South-West, Dr. Winifred Cullis, who made a plea for an increase in the number of films for teaching physiology, and Lieut. M. G. Bowden of the U.S. Army, who gave the conference an account of the extent to which visual aids were used in America. The conference was attended by Polish, Dutch and Canadian representatives, as well as by English teachers and film-makers.

## Crop-cutting Survey of Wheat in the Punjab

PRELIMINARY results have just reached Great Britain of an interesting example of random stratified sampling on the grand scale, devised by Dr. P. V. Sukhatme, statistician to the Imperial Council of Agricultural Research, New Delhi, and carried out by the Department of Agriculture of the Punjab. By sampling a hundred out of the total of nine million acres under wheat, the net out-turn of that crop for twenty-seven of the twenty-nine districts of the Province is estimated at 3,448,700 tons, with a standard error only just over 1 per cent. The cost of the survey scarcely exceeded Rs. 1,000 per district.

Uniformity of practice was obtained by central training of the senior staff concerned in all the details of the experiment, and also by central selection of the 748 villages (about 2 per cent of the total number available) used for the scheme. These were, for each district of the Province, proportionate in number to the area under wheat, but equally distributed among the tehsils of the district, and randomly within each tehsil. Within each village three fields were selected (since previous experimentation had shown little difference between the variation between villages and that between the fields of a village, and practical considerations of time, labour and cost counselled concentration of fields within a village), and within each field one plot of 1/20 acre (the variation between plots in a field being less than that attributable to either source just mentioned). Selection of the fields in villages and of the plot in each field was by use of random numbers supplied by the centre, which was able to check the process. Harvesting, threshing, winnowing and weighing were normally completed in one day. The final estimate includes adjustments for 'driage' owing to the divergence of this procedure, necessary for accuracy and speed, from the general practice (which allows a week or two for drying between harvest and threshing), and also for the different yields of wheat sown pure or mixed with other crops.

## Improved Use of Daylight

Two useful recent publications deal with the more effective use of natural daylight. "The Natural Lighting of Houses and Flats with Graded Daylight Factor Tables", by T. Smith and Miss E. D. Brown of the National Physical Laboratory (London: H.M. Stationery Office, 4*d*. net), gives guidance in the choice of window dimensions for houses and flats. The penetration of daylight through a window is discussed, and tables are given from which the penetration of daylight for different window dimensions may be assessed. These tables are for daylight factors of 2, 1 and 0·5 per cent respectively. "Natural Lighting", Lighting Reconstruction Pamphlet No. 4 issued by the Illuminating Engineering Society (1*s*.), deals with the subject in a descriptive manner, and shows particularly the benefit derived from high windows and the suitable planning of buildings. In the most favourable circumstances, a daylight factor of 5 per cent may be attained at the working table, and in no case should the daylight factor be less than 0·2 per cent.

## Announcements

MR. R. H. HILL, secretary of the Bodleian Library, has been appointed librarian and secretary to the Trustees of the National Central Library, in succession to Dr. Luxmoore Newcombe, who retires at the end of the year.

BOOKS and prints relating to various States of Central and South America, the West Indies and the Antarctic, as well as some rare old maps are the subject of Catalogue 671, issued by Messrs. Francis Edwards, Ltd., Marylebone High Street, London, W.1. The catalogue includes several rare items: a complete set of the *Challenger* results in forty-one volumes; J. Colnett's "Voyage of Whaling and Discovery" (1793–94), with his manuscript journal of the same date; the manuscripts of several of Cunninghame Graham's books; Grynaeus' "Novus Orbis", with the rare map of 1532; the first Latin edition of Munster, "Cosmographiae Universalis" (1550); "Purchas his Pilgrimes" (1624–26); Apian's map of America (1520); and Arrowsmith's chart of the Pacific (1798).

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Marine Biological Research in Great Britain

THE letter published in *Nature* of July 29 from Prof. F. E. Fritsch opens an important subject which has been in the minds of a number of zoologists during the past few years, and it is one in connexion with which some of us would be extremely glad to see action taken on the lines which Prof. Fritsch indicates. Whatever this action may be, it is essential to realize from the outset (as Prof. Fritsch does) that nothing short of one or more teams of full-time workers will meet the case adequately; the problems involved are too numerous and too complex to make a part-time attack on them any longer profitable. One can envisage valuable part-time assistance for the team, but a nucleus of full-time workers is indispensable.

It is not clear whether Prof. Fritsch has more in mind the benthic communities which exist between tidemarks, or those below tidemarks—presumably both. In fact, the need for new advances is very great in both fields, but the methods required for offshore work are very different from those appropriate between tidemarks, and undoubtedly different groups of workers should tackle the two aspects. As my own particular interest is in the intertidal zone, I should like to offer a comment referring to this belt, leaving the development of the offshore theme to others more competent to deal with it.

My own approach to British shore ecology has been through foreign waters, beginning with the Great Barrier Reef Expedition in 1928–29, extending to other tropical coasts, and including ten years in South Africa, where one sees a complete transition from sub-tropical to almost sub-antarctic conditions. During the years 1931–40 I was able, with the assistance of a dozen collaborators, to carry out a preliminary general survey of the South African coast, covering a distance of more than 1,800 miles, which was visited at about a hundred localities altogether[1]. Having done this, we naturally wished to compare our results with those arrived at in other countries, but it is very striking how little there is with which *direct* comparison is possible, despite the existence of a considerable literature. We reach, therefore, the rather astonishing conclusion that the intertidal region of South Africa (almost unknown, ecologically, in 1930) is probably, at the moment, better known, in its broad outlines, than any stretch of coast of comparable length in the world. The work from another area most nearly comparable with it is that of Fischer-Piette from the French and Channel coasts; one can piece together a rather imperfect picture for the coasts of North America (especially the Pacific coast); there are the accounts of coral reefs; but many regions of the world are unknown altogether, or known from one or two isolated papers only. A *general* picture of the tidal belt round the British coasts does not exist, in spite of our detailed knowledge of particular localities. This will be partly remedied so far as Algæ are concerned when surveys carried out during the present War are published; for animals there is an immense amount of work still to be done.

It is important to emphasize, in this connexion, that we shall never get a satisfying picture of the British coasts until we can fit them, in their due relation, into the larger picture of the world as a whole. Advances in the ecology of large areas have affected the land, fresh water, and the oceans much more than the tidal region; and a preliminary general statement covering intertidal biology in the world as a whole is very much needed. The need for relating Britain to this general picture can best be illustrated by a specific example. The South African survey mentioned above began as an attempt to solve the problem presented by the action of ocean currents on the coasts of the thirty-mile-long Cape Peninsula, a region of special zoo-geographical interest. It was immediately discovered, however, that this problem was literally insoluble until some sort of picture of the South African coast as a whole had been obtained; once the latter was available, the Peninsula became intelligible. Similarly, Britain will probably never become fully intelligible until its relation to the rest of the world is better understood than at present.

I do not wish to imply that future developments in Britain need necessarily repeat the particular type of work already done in South Africa. It has been pointed out that geographically Britain is a much more difficult and confused region than South Africa, unlikely to give clear-cut results, and that the amount of work needed to obtain the results would be out of proportion to their value. However this may be, it will be agreed by most people that a great deal of further work of *some* types is needed on the British coasts.

I should like, therefore, to develop Prof. Fritsch's thesis to this extent, that we need three things, involving three different modes of attack, and each of them demanding a team of full-time workers. These are (*a*) further work on the British coasts between tidemarks; (*b*) further work on the continental shelf of the British region, below tidemarks; and (*c*) an attempt to make a preliminary world-statement, based on a carefully selected series of samples, all seen by the same workers. As a matter of fact, there exist fairly detailed plans covering certain parts of the programme just outlined, and it would seem desirable that those most immediately concerned should consult together as to the best means of giving effect to such plans.

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[1] A general account of this survey is in the press and due to appear in the next issue of the *Annals of the Natal Museum*; earlier parts of the work are described in a series of papers in that journal, and also in *J. Linn. Soc.* (*Zool.*), *Trans Roy. Soc. S. Africa* and other periodicals.

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WE have read with interest Prof. F. E. Fritsch's letter on marine biological research in Great Britain[1], in which he stresses the need for the co-operation of botanists and zoologists in the investigation especially of marine benthos and refers to the difficulties and limitations experienced by investigators in universities at a distance from the sea.

We should welcome the new developments which Prof. Fritsch envisages as desirable at Plymouth. It seems to us that, whether or not these materialize,

there is ample room also for similar developments elsewhere. In particular, centres for 'academic' research, complementary to, and co-operating with, Plymouth, would find adequate opportunity for useful work. We have had such a centre in view in planning our development policy here and in preparatory work that has been in progress for a number of years.

In Bangor we are exceptionally favoured, in close proximity to a littoral fauna and flora which, both in variety of habitats and in wealth of interesting species, must be judged to be among the richest in the kingdom. Certainly no other university institution in Great Britain is better provided in this respect at its very doors. Consequently marine biology has always taken a prominent place in our university courses. A vacation course in marine zoology, which draws students from many other universities, has been held annually for the last thirteen years. We have regarded marine biology, moreover, as a subject which should have high priority in the promotion of research in this College.

Much is already known about the fauna of this area, as can be seen from a glance at the pages of almost any standard systematic work on British marine animals—for example, Alder and Hancock's "British Nudibranchiate Mollusca"; moreover, the pioneer work of Sir William Herdman and his collaborators provides a preliminary survey of the fauna. The staff of the Zoology Department has been for a number of years compiling a fauna list from these records and, with the help of a number of visiting workers, has extensively added to it. Though much remains to be done before this list can be regarded as sufficiently complete for publication, we already have a good working knowledge of the principal species and their distribution.

Parallel information on the marine flora has been accumulated by members of staff of the Botany Department, supplementing the earlier records of Prof. R. W. Phillips, whose algological library is housed in the Department. The work done by Phillips and Lloyd Williams created a local tradition which we feel should be maintained.

Prof. Fritsch has stressed the importance of the benthic diatoms. Other components of the microflora may also prove of great importance. The study of the marine microflora is a natural extension of a study of the freshwater microflora of this district which is already being carried on intensively.

Aware of the opportunities our situation offers and conscious of the need for providing special facilities for the study of marine biology in at least one of the constituent colleges of the University of Wales, the Council of this College has included among its principal post-war aims the founding of a marine biological station at Bangor, to serve the needs of academic research and teaching within the Principality. We hope that this might also serve in part the wider need to which Prof. Fritsch has directed attention.

To be reasonably useful and efficient, such a station as we plan would require a team of workers covering the various aspects of marine biology, both floral and faunal. The advantage of founding such a station in close conjunction with our existing departments is obvious, since the staffs of these departments would go some way towards providing the nucleus of a team. We hope, too, that we shall have the co-operation of our colleagues who are interested in marine biology from the other Colleges of this University.

F. W. ROGERS BRAMBELL.
D. THODAY.
University College of North Wales,
Bangor. Aug. 1.

[1] *Nature*, 154, 144 (1944).

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I WOULD like to endorse Prof. F. E. Fritsch's letter in *Nature* of July 29 on this subject. It is regrettable that a country such as ours with many suitable habitats for marine algæ should lag behind Continental countries in the study of this particular group of plants. Both the last and the present Wars revived an interest in the marine algæ, and the present War has certainly shown how ignorant we still are about many fundamental facts of the life-history of seaweeds. Some of these problems are now being solved and the gaps in our knowledge closed, but it is important that the work should not cease when the War ends. The establishment of a centre for this work is long overdue. At the recent annual meeting of the Marine Biological Association, it was hoped that at least one if not more whole-time workers on marine algæ might be appointed at the end of the War. This may well be a start in the direction indicated by Prof. Fritsch.

As regards the establishment of centres outside Great Britain, some time ago I advocated in *Nature*[1] the establishment of a research station in the West Indies with an algologist on the permanent staff. This station I suggested should be administered by British universities. Since then, the Commission on Higher Education has visited the West Indies and it is going to propose the establishment of a university college in the islands. A research station such as I envisaged may well form part of such a college. It remains to be seen what the Commission suggests in its report.

V. J. CHAPMAN.
Botany School, Cambridge.

[1] *Nature*, 152, 47 (1943).

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## Action of Pepsin on Acylated and Non-acylated Cysteine- (Cystine-) Tyrosine Peptides

IN connexion with some projected immunochemical work, we have recently had occasion to synthesize cysteyl- and cystyl-tyrosine and tyrosyl-cysteine and -cystine. Since these peptides represent a type which has not hitherto been available, it was considered worth while to study the action on them and their N-carbobenzyloxy derivatives of crystalline pepsin.

So far the only synthetic substrates known to be attacked by pepsin are certain derivatives of peptides containing tyrosine or phenylalanine and glutamic acid, in which the amino group of the aromatic amino-acid is combined with the α-carboxyl group of an acylated glutamic acid[1]. The peptic hydrolysis of these substrates occurs most rapidly at $p$H 4·0 and scarcely at all below $p$H 2·0; no hydrolysis of the free peptides takes place and the reaction is further inhibited if the free carboxyl group of the glutamic acid residue is blocked. On the basis of these observations, Bergmann[2] has drawn the general conclusion that hydrolysis by pepsin is conditional on the absence of a free amino group from the immediate

neighbourhood of the linkage attacked, and that a substrate for peptic action must contain more than one free carboxyl group.

Some of our own observations on the cysteine-(cystine-) tyrosine peptides are given in the accompanying table, from which the following conclusions may be drawn: (1) This group of compounds includes some which offer good examples of simple synthetic substrates for peptic action. (2) The action of pepsin on these substrates is much more marked at *p*H 4·0 than at *p*H 1·8, although in two cases at least it is still significant at the latter reaction. (3) While the N-acylated peptides are more rapidly hydrolysed, the action of pepsin extends in this series to the free peptides, which thus represent the first true peptides shown to be attacked by this enzyme.

PERCENTAGE SPLITTING OF ACYLATED AND NON-ACYLATED CYSTEINE-(CYSTINE-) TYROSINE PEPTIDES BY CRYSTALLINE PEPSIN IN 48 HR. AT 37°.

| | *p*H 4·0 | *p*H 1·8 |
|---|---|---|
| A. ACYLATED PEPTIDES | | |
| N-Carbobenzyloxytyrosylcysteine .. .. | 39 | 10 |
| N-Carbobenzyloxytyrosylcystine .. .. | 7 | 0 |
| N-Carbobenzyloxycysteyltyrosine .. .. | 53 | 32 |
| N-Carbobenzyloxycystyltyrosine .. .. | 21 | 6 |
| N-Carbobenzyloxy-S-benzylcysteyltyrosine .. | 26 | — |
| B. NON-ACYLATED PEPTIDES | | |
| Tyrosylcysteine .. .. .. .. .. | 22 | 8 |
| Tyrosylcystine .. .. .. .. .. | 5 | 8 |
| Cysteyltyrosine .. .. .. .. .. | 31 | 21 |
| Cystyltyrosine .. .. .. .. .. | 5 | 0 |

In view of these results, it seems that the generalization of Bergmann regarding the necessary conditions for peptic action requires modification. In none of our cysteine derivatives (which are the more readily hydrolysed) is there more than one free carboxyl group, and the hydrolysis of the free peptides is unmistakable; it is especially noteworthy that one of the free peptides (cysteyltyrosine) is significantly hydrolysed at *p*H 1·8, a reaction at which the amino group will be charged.

A further point which seems to us to be of interest emerges from our experiments. It will be noted that the rate of hydrolysis is conspicuously greater, both with the acylated and non-acylated peptides, when these are in the reduced form; that this increased susceptibility to peptic action is due to the presence of free –SH groups is further shown by the fact that blockage of the –SH group of N-carbobenzyloxycysteyltyrosine with a benzyl residue reduces its rate of hydrolysis to that of the corresponding cystine derivative. This greater susceptibility of the cysteine derivatives to peptic hydrolysis may be related with the facts that: (*a*) pepsin attacks proteins more vigorously when they are in the denatured than in the native state; and (*b*) denaturation of proteins is accompanied by the appearance of –SH groups. Taking into account our own observations and the known fact that free tyrosine can be liberated from proteins by pepsin, it seems not unlikely that at least one point of attack of a denatured protein by this enzyme may be a cysteyltyrosine or tyrosylcysteine linkage.

A complete account of the synthesis of the peptides described above and of the enzymic experiments is being submitted for publication elsewhere.

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ROSALIND V. PITT RIVERS.
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London, N.W.3.
Aug. 8.

[1] Fruton, J. S., and Bergmann, M., *J. Biol. Chem.*, 127, 627 (1939).
[2] Bergmann, M., and Fruton, J. S., "Advances in Enzymology", 1, 63 (1941).

# Effect of Adrenalectomy and Anterior Pituitary Injections on Mammary Development

THOUGH mammary growth has been stimulated experimentally with desoxycorticosterone[1,2], the possible significance of the adrenal cortex in normal and experimental mammary development has scarcely been investigated from other aspects. Elucidation of the role of the adrenal cortex in mammary development assumes added importance in view of the claim that the agents directly responsible for the growth of the mammary gland are two mammogenic hormones, secreted by the anterior pituitary, which cause growth of the mammary ducts[3] and alveoli[4] respectively. The possibility must be considered that the mammogenic action of anterior pituitary extracts may be mediated, wholly or in part, by the adrenals. We have accordingly begun a study of the effect of adrenalectomy on the mammary gland in relation to the mammogenic action of the anterior pituitary. A preliminary account of the results so far obtained may be of interest.

In this study we have used a fresh saline extract of ox anterior pituitary[5], for the gift of which we are indebted to Prof. F. G. Young. Using immature gonadectomized rats, it was found that this extract evoked a striking increase in the degree of arborization of the mammary duct system. To use a rough analogy, whole mounts of the mammary glands of control and injected rats were reminiscent of the appearance of a deciduous tree in winter and late spring respectively.

Having established that this pituitary extract possessed marked mammogenic activity, an experiment involving adrenalectomy was set up. This involved four groups, each of 5 male rats, and four of 6 female rats, all gonadectomized at 27 days. Two groups of either sex were adrenalectomized at 74–85 days, and one group of adrenalectomized and one of non-adrenalectomized rats of either sex received ten daily subcutaneous injections of 0·4 ml. anterior pituitary extract (equals 100 mgm. fresh tissue). At the end of the injection period, whole mounts (hæmatoxylin) of all the mammary glands, normally 10 in the male and 12 in the female, were prepared and the glandular areas measured.

The glands were examined under the low power (× 15) binocular and each assigned a score on a subjective scale on the basis of the degree of the arborization of the duct system, the number of lateral buds and the presence of the deeply staining club-shaped end buds characteristic of actively growing ducts. The results indicated once again that in both sexes the pituitary extract increased the complexity of the duct system; only in males, however, was there any evidence of a decreased effect in adrenalectomized rats. In uninjected animals, in contrast to previously reported experiments[6,7], adrenalectomy had no discernible effect on mammary structure. In a majority of the non-adrenalectomized males injected with anterior pituitary, the mammary ducts, though not very complicated, were dilated and lined with deeply staining and distended structures which appeared to be alveoli; in contrast, the comparable group of adrenalectomized males showed thin, branching duct systems. The appearance of the former glands was reminiscent of that of glands described by Astwood *et al.*[8] in normal adult male rats or in gonadectomized immature rats of both

Mean total areas (mm.²) of the mammary glands of groups of rats.

| | Uninjected, non-adrenalect. rats | Non-adrenalect. rats injected with ant. pit. ext. | Uninjected, adrenalect. rats | Adrenalect. rats injected with ant. pit. ext. | Stand. Error of single mean* | Stand. Error of comparison of four means* | Stand. Error of comparison of two means* |
|---|---|---|---|---|---|---|---|
| Males | 609·2 | 559·3 | 458·2 | 457·5 | 54·1 | 108·3 | 76·5 |
| Females | 919·4 | 1376·8 | 863·6 | 842·8 | 121·8 | 243·6 | 172·2 |

* Obtained from an analysis of variance.

sexes treated with androgens. It seems possible that in males, at least, the pituitary injections evoked the secretion of adrenal cortex steroids with androgenic activity.

The mammary area data were summed for each rat and the results for each sex subjected to an analysis of variance. For help with the statistical analysis we are indebted to Dr. K. L. Blaxter and Dr. K. Mather. The mean values for each group and the standard errors are given in the accompanying table. In both sexes the total mammary gland area (which was greater in females than in males) was significantly decreased by adrenalectomy ($P = 0{\cdot}02$ for males and 0·03 for females), a result not in agreement with the only two previous reports[6,7] we have been able to find on this subject. The results also suggest that, in females, anterior pituitary treatment increased the mammary gland area in the presence of the adrenals but not in their absence; the probability ($P = 0{\cdot}06$) was, however, not very great, and this conclusion cannot be taken as established unless the results are confirmed by those of other experiments, at present in progress, in which, it is hoped, conditions will be more favourable for the demonstration of the expected effects. In males, there was no evidence that the anterior pituitary extract had any effect on mammary gland area, either in the presence or absence of the adrenals.

The implication of the foregoing results is that the intervention of hormones of the adrenal cortex must be taken into consideration in relation both to normal and experimental mammary development.

We are indebted to the Agricultural Research Council for a research grant to one of us (A. T. C.) and to Dr. S. K. Kon for facilities for working with rats.

A. T. Cowie.
S. J. Folley.

National Institute for Research in Dairying,
University of Reading.
June 22.

[1] Van Heuverswyn, J., Folley, S. J., and Gardner, W. U., *Proc. Soc. Exp. Biol. N.Y.*, **41**, 389 (1939).

[2] Speert, H., *Bull. Johns Hopkins Hosp.*, **67**, 189 (1940).

[3] Lewis, A. A., and Turner, C. W., *Res. Bull. Mo. Agr. Exp. Sta.*, No. 310 (1939).

[4] Mixner, J. P., and Turner, C. W., *Res. Bull. Mo. Agr. Exp. Sta.*, No. 378 (1943).

[5] Young, F. G., *Brit. Med. J.*, ii, 897 (1941).

[6] Butcher, E. O., *Proc. Soc. Exp. Biol. N.Y.*, **42**, 571 (1939).

[7] Reeder, C. F., and Leonard, S. L., *Proc. Soc. Exp. Biol. N.Y.*, **55**, 61 (1944).

[8] Astwood, E. B., Geschickter, C. F., and Rausch, E. O., *Amer. J. Anat.*, **61**, 373 (1937).

## Effects of Administration of Trinitrotoluene

Several workers have shown that the administration of aromatic nitro- and amino-bodies to the human being results in cyanosis and porphyrinuria, indicating a disturbance of pigment metabolism. Trinitrotoluene (T.N.T.), for example, may damage the liver and cause anæmia, jaundice and porphyrinuria, and serious effects on the health of munition workers can result. A short while ago, we were investigating the action of T.N.T. upon the hæmopoietic system in healthy rats and, as its metabolism in the body has now been studied extensively[1], we think it is of interest to record some of our results here.

Groups of three male albino rats (150–200 gm. each) were maintained in metabolism cages on a daily fixed weight of porphyrin-free diet in a paste form as used in earlier experiments[2]. The animals were allowed free access to water and their urines were collected in flasks containing toluol. Every two days the urines were collected and transferred to volumetric flasks and made up 100 ml. with the cage washings. The improved Webster test for T.N.T. derivatives[3] was performed on each, and the porphyrin content in the remainder estimated using Rimington and Hemmings' technique[4]. After three control periods each of two days during which excretion values per 100 gm. body weight became fairly constant, three groups of rats were injected subcutaneously with varying doses of a suspension of T.N.T. in 2 per cent acacia mucilage in tap water. Each dose was given per body weight. Injections of the same dose were given every two days in alternate flanks of the back. Each animal received nine injections. One control group of rats received a corresponding dose of mucilage of acacia only. All the conditions were standardized so far as possible.

After one injection, the urines from the rats receiving T.N.T. were red, now shown to be probably a derivative of 2 : 4 : 6-trinitrobenzyl alcohol[1], and later the acid shakings of the ether extracts became light brown. Unidentified brown pigments often accompany increases in porphyrin excretion. Throughout the experiments, coproporphyrin only was identified in the urine by measuring the absorption graph in 25 per cent hydrochloric acid. It was probably the Series III isomer, though this was not confirmed. Group I receiving 200 mgm. T.N.T. per kgm. showed no significant change in urinary porphyrin in the time studied; mean total urinary porphyrin per 100 gm. body weight before injection was 4·6 μ gm. per 2 days, and after dosage was 5·5 μ gm. Group 2 receiving 400 mgm. T.N.T. per kgm. showed an increase after six injections (5·8 μ gm. to 11·3 μ gm.), while Group 3 receiving 600 mgm. T.N.T. per kgm. showed porphyrinuria after four injections (4·0 μ gm. to 11·8 μ gm.). Liver damage was noted in this latter group by taking sections and also staining for iron. The stomachs of these rats were very brown and blown up. The modified Webster's test was completely negative throughout, confirming previous views that porphyrinuria is not related to the presence of T.N.T. in the urine[5]. Values of urinary porphyrin for the control group were 6·1 μ gm. before injection and a mean of 6·9 μ gm. following acacia dosage.

Four further groups of adult male albino rats (150–200 gm. each) were similarly treated but received the dosage of T.N.T. by stomach tube. The

onset of porphyrinuria was expected to be quicker. Group 1 showed no change in urinary porphyrin, but Groups 2 and 3 showed extensive porphyrinuria following two injections of 400 and 600 mgm. T.N.T. per kgm. respectively (1·9 $\mu$ gm. to 6·3 $\mu$ gm., and 5·4 $\mu$ gm. to 15·5 $\mu$ gm.). The acid shakings of the urines of these two groups were dark brown. The modified Webster's test was again negative throughout, and the control group showed no change in porphyrin output.

The results show that the absorption of T.N.T. in the rat takes place more rapidly in the stomach than by subcutaneous injection; the toxic effects such as porphyrinuria and liver damage follow more quickly. A red urine was not produced by administering doses of 2 : 4-dinitrotoluene or of *p*-nitrotoluene, and it is suggested that three nitro-groups are necessary for the formation of the red colour.

G. F. SOMERS.
G. B. WEST.

College of the Pharmaceutical Society,
London, W.C.1.

[1] Channon, Mills and Williams, *Biochem. J.*, **38**, 70 (1944).
[2] West, *Quart. J. Pharm.*, **14**, 26 (1941).
[3] Ingham, *Lancet*, 554 (Nov. 8, 1941).
[4] Rimington and Hemmings, *Lancet*, **1**, 770 (1938).
[5] Kennedy and Ingham, *Brit. Med. J.*, **1**, 490 (1942).

## Birds and Butterflies

CAPT. C. R. STONOR, under this heading in *Nature* of July 15, p. 80, says that he "did not see a single bird, of any species, catch or chase a butterfly" during a month in rain-forest in South India. One can only comment that abundant evidence was provided from tropical Africa by the late C. F. M. Swynnerton. This outstanding field naturalist, well known for his work on tsetse control, could not find time, while engaged in this work, to sort out the massed observations for publication. After his lamented death in an aeroplane crash, it fell to my lot to edit some of his material[1].

It is interesting to note that some of the subjects of these records were the same families—or even genera—of birds as were seen by Capt. Stonor not catching butterflies; for example, rollers, bee-eaters, drongos. Capt Stonor especially mentions the "large racquet-tailed drongo" in his negative evidence, and I would refer him, and readers, to my note[2] in which I showed photographs of two butterflies from different parts of the range of this bird, each bearing a clearly imprinted mark on a wing closely corresponding with the imprint of the bill of a specimen.

Not only does the study of such beak-marks provide evidence that butterflies are attacked but also, as I showed in 1941[3], it has provided significant evidence that the attacks are less destructive of the aposematic ('warningly coloured') species which serve as models for mimicry than those mimicking them. Regarding Capt. Stonor's statement that he saw no beak marks, I may perhaps be excused for saying that they are not always so obvious as those I have mentioned above, and particularly in "tattered specimens" which have been mauled and rubbed so that the density of the scaly covering is reduced; experience in close study of 'set' specimens is needed.

The statement that "the butterflies seldom flew higher than four or five yards from the ground; while most of the insectivorous birds . . . feed twenty feet up at the least", presumably means that it is considered that at high levels there are no butterflies to be attacked. This, however, is far from being the case. It is recorded by Beebe[4], Hingston[5] and Chapin[6] that the fauna of the tree-tops is distinct from that at lower levels, and Hingston particularly notes "Butterflies are commonly seen fluttering over the canopy. Some species probably never come to earth." Most butterfly collectors in the forests must have had my exasperating experience of seeing desirable specimens flying around and settling on the tops of trees in flower. The oriental butterfly *Eriboea schreiberi* Godt. is particularly interesting in this connexion. It is stated by Fruhstorfer[7] to be 'extremely rare' (that is, in *collections*) and he also says "It is also frequently stated that single wings are found from which we may conclude that *schreiberi* is very much pursued by birds". The same curious fact is the subject of comment by Poulton in his notes attached to G. A. K. Marshall's records of attacks on butterflies[8].

G. D. HALE CARPENTER.

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[1] *Proc. Linn. Soc. Lond.*, Session 1941–42, Part 1, 1 (1942).
[2] Carpenter, G. D. Hale, *Proc. Roy. Ent. Soc. Lond.*, A, **18**, 25, Pl. 1 (1943).
[3] Carpenter, G. D. Hale, *Proc. Zool. Soc. Lond.*, A, **111**, 223 (1941).
[4] Beebe, C. W., "Tropical Wild Life in British Guiana" (New York, 1917), 81.
[5] Hingston, R. W. G., "A Naturalist in the Guiana Forest" (London, 1932), pp. 62, 350, 353–354.
[6] Chapin, J. P., "The Birds of the Belgian Congo", *Bull. Amer. Mus. Nat. Hist.*, **65**, 224 (1932).
[7] "The Macrolepidoptera of the World". Edited by A. Seitz. IX. The Rhopalocera of the Indo-Australian Faunal Region (Stuttgart, 1908), 725.
[8] Marshall, G. A. K., *Trans. Ent. Soc. Lond.*, 365 (1902).

## A New Species of Amœba: *A. kerrii*

SINCE the publication of full details with relevant plates and drawings will necessarily be long delayed, the following account of a new species of amœba belonging to Schaeffer's genus Metachaos, isolated from some water-weeds collected on the shore in front of the Marine Biological Station of Keppel by Miss Maureen McAlister in 1939, and now under cultivation in Notre Dame Laboratory, will serve as a preliminary notice to other workers.

Species of the genera Chaos and Metachaos are distinguished by their cytoplasmic characteristics or by details of their life-history. This amœba, named in honour of Sir John Graham Kerr, who first emphasized the urgent necessity of research on an organism so universally used for education in biology, is easily identified in its fully adult and senile stages by its dusky appearance when viewed over a black background by reflected light, this dark colour being due to the extraordinary abundance of crystals which distend the cytoplasm and completely mask the presence of the nutritive spheres. The nucleus by contrast looks almost like a vacuole as it is rolled about in the cytoplasm.

Young adults and adolescents are much clearer and more like the typical appearance of most of the free-living, large amœbæ. Pure-line cultures of *Amœba kerrii* are easily established, the creature feeding on rotifers, ciliates and flagellates. Wheat grains form a suitable pabulum.

Fission divisions occur in adolescent and in young adults, but not in old or senile adults, once in three

days, at a suitable temperature. The line of demarcation between two daughter amœbæ travels down from north to south of the fission sphere (= the form assumed by the dividing amœba), which remains firmly in contact with the substratum during the whole process of division. In this it resembles *A. proteus* γ and *A. discoides*, and differs from *A. lescheræ*. Division of the nucleus is mitotic and takes place within the nuclear membrane; the chromosomes are small and numerous. The telophasic stages are semi-elliptical in outline, in contradistinction to those of *A. lescheræ*, which are more or less triangular. The ectoplasm, which has no longitudinal folds, is tougher than that of the other amœbæ we have investigated. This is an especially useful characteristic for the study of the developing young, permanent preparations of which are, in consequence, more readily made.

The resting nuclei of both adult and developing amœbæ are of the typical form. In the former, a central karyosome suspended in an achromatic network is separated by a clear area from the region of the regularly disposed chromatin blocks lying just under the nuclear membrane. A variety of form consequent upon the fact that the nucleus is rolled about into all sorts of positions by the surrounding cytoplasm may be seen when large numbers of *A. kerrii* are fixed and stained.

The reproductive cycle commences with the emission of chromidia from the nucleus of an adult amœba into the surrounding cytoplasm. Each chromidial mass becomes the rudiment of the nucleus of the new amœba, which is differentiated in the agamont and becomes an encysted agamete. Hundreds of these are shed into the surrounding medium, where they remain for a varying period of time. Hatching out of the young amœba, which is only just visible under a ⅙-in. objective, is more easily observed in winter. A limax form is that most often assumed by the growing young amœba, the nucleus of which is easily visible. In about eight months the whole life-cycle of *A. kerrii* is completed.

MONICA TAYLOR.

Notre Dame,
Dowanhill,
Glasgow.
July 2.

## Boundaries of Space and Time

IT is with some diffidence that I venture to comment on the very abstruse issues raised by Prof. Dingle in his Halley Lecture (*Nature*, **153**, 731, 758; 1944) but there is an aspect of the matter to which it seems worth while to direct attention.

The theory of relativity tells us that observable space has a boundary, the extent of which can be approximately estimated, and that any events which may take place, or which may have taken place, at or beyond this boundary are unknown and unknowable. It would also appear that the interpretation of events which may appear to occur near the boundary must be indeterminate, because it is impossible to say to what extent they may be influenced by events or conditions beyond the boundary, of which, it is agreed, we can have no knowledge. Moreover, it may be suggested that this doctrine of a boundary to the observable universe is reasonable whether we accept the other implications of the theory or not.

The boundaries of comprehensible time, past and future, are not known with the same precision as the boundaries of observable space, but it is reasonable to postulate that such boundaries must exist, and that any discussion of events which lie beyond these boundaries is meaningless.

The purpose of the present letter is to point out an important consequence which follows from these postulates: when we are discussing events lying within these boundaries of space and time, we are not entitled to introduce into our argument any assumptions as to conditions at the boundaries or beyond them. Thus we are not entitled to favour theories which enable us to extend the boundaries of time to infinity any more than we are entitled to favour theories which postulate an infinite extension of space. Provided that the boundaries of time permitted by a theory are sufficiently extensive to be consistent with observed facts, no more can be demanded of it.

There is also a further point. We live in a world of change, but there are certain properties of the universe as we know it which appear to be constant in time. It must be remembered, however, that our observations extend over an interval of time which is infinitesimal compared with the periods of time which we are wont to discuss, and we do not therefore appear to have any reliable means of determining whether these apparently constant quantities are in fact constant, or whether they are slowly variable over long periods, and if so in what sense. Where two or more theories are consistent with the observed facts and differ only in respect of the conditions which they involve at the boundaries of space and time, the selection of one theory or another would appear to be entirely a matter of convenience.

K. E. EDGEWORTH.

Cherbury,
Booterstown,
Co. Dublin.

THE theory of relativity tells us that observable space may not be infinite in extent, but it does not postulate a boundary; "finite but unbounded" is the usual phrase. The theory gives no support to the idea that observable events can be influenced by conditions outside the region of possible observation, nor does it set any limits to time. In this respect time differs from space. The last paragraph of Colonel Edgeworth's letter is perfectly correct in principle, but the range of our present knowledge can scarcely be called infinitesimal. A quantity may change so slowly as to appear constant, but the progress of science consists partly in extending the range of observation so as to detect such changes; the slowing down of the earth's rotation, and the reddening of nebular light, however it be interpreted, are examples. It is always possible, of course (unless constancy is postulated by definition), to say that an apparently constant phenomenon is changing too slowly for detection; but any theory which included this assumption would probably give some indication of the rate of change, and further knowledge would enable us to determine whether the assumption was valid. The question of retaining the theory would then be decided on grounds other than convenience.

HERBERT DINGLE.

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# ROYAL SOCIETY OF CANADA

## ANNUAL MEETING

THE 1944 meeting of the Royal Society of Canada was held at the University of Montreal during May 29–31 under the presidency of Mgr. Olivier Marault, rector of the University.

New fellows presented at the first general meeting included the following in the scientific sections: Section III (Chemical, Mathematical and Physical Sciences): R. C. Dearle, G. S. Field, John T. Henderson, G. de B. Robinson, W. Ure; Section IV (Geological Sciences): J. W. Ambrose, G. V. Douglas, H. B. Yates; Section V (Biological Sciences): J. A. Anderson, W. V. Cone, G. E. Hall, W. F. Hanna, Georges Maheux, D. S. Rawson. Lieut.-General A. G. L. McNaughton, who had been elected an honorary fellow in 1941, while he was absent from the Dominion as Commander-in-Chief of Canada's Army Overseas, was also presented.

The Society's medals were presented at the evening meeting on May 29 as follows: Flavelle Medal to Prof. Velyien E. Henderson, professor of pharmacy and pharmacology in the University of Toronto, in recognition of contributions to knowledge in the fields of pharmacology, physiology and therapeutics, including the discovery of the anæsthetic properties of cyclopropane; Henry Marshall Tory Medal to Prof. Frank Allen, professor of physics in the University of Manitoba, for his contributions to the subjects of optics and acoustics and especially to a border region of physics and physiology; Tyrell Medal to Prof. Harold A. Innis, professor of political economy in the University of Toronto.

Following the presentation of the medals, the presidential address "Montréal: une Synthêse" was delivered by Mgr. Marault. A popular lecture on "War, Peace and Commerce" was given on the evening of May 30 by Dr. B. K. Sandwell.

In Section III, the presidential address by Prof. T. Thorvaldson, professor of chemistry in the University of Saskatchewan, dealt with "The Solid State". It reviewed the various theories of chemical reactions in the solid state and the experimental evidence in support of them. This was followed by a symposium on the same subject, in which Prof. M. A. Peacock described the methods of identification of solid phases by crystallographic means and Prof. E. F. Burton showed some recent photographs taken with the Toronto electron microscope of the forms of solid particles of ultramicroscopic dimensions. The final paper of this symposium, by Dr. G. S. Whitby, was on rubber, and described the chemical constitution and related physical properties of several of the new artificial rubbers now being produced.

Among the thirty-two other papers presented to the Section, mention may be made of one by Prof. Frank Allen, in which results of experiments on the sensitivity of the colour sensations were described. He finds that when the right eye, for example, is adapted to red light, the red sensation is reduced, but in the left eye all three sensations (red, green and violet) are enhanced. If the eye is rested after adaptation for three minutes, a reversal in sensitivity occurs. There is thus an oscillation of sensitivity. A paper on further simplification in thermodynamical calculations along lines previously developed was read by Prof. A. N. Shaw. Dr. J. A. Pearce and E. C. Walker reported the orbital elements of λ Andromedæ based on a series of measurements made on high-dispersion spectrograms taken at Victoria, B.C. Dr. E. C. Beale discussed results which indicate that some new molecular absorption lines recently discovered show characteristics closely similar to atomic lines. It is suggested that their probable origin is to be found in the solid particles responsible for general absorption in interstellar space, and that laboratory investigations of the absorption spectra of such particles as are likely to be present in interstellar space might be fruitful in their identification. A new mechanical height computer for *radio sonde* observations was described and shown by Dr. W. E. Knowles Middleton. Dr. J. A. Pearce, of the Dominion Observatory, was elected president of the Section, and Prof. C. T. Sullivan, Repath professor of pure mathematics at McGill University, vice-president.

In Section IV, the presidential address by Dr. W. A. Bell, palæobotanist of the Geological Survey of Canada, dealt with the use of some floras in Canadian stratigraphy. Fossil floras have proved very useful in subdividing the very thick carboniferous sediments of the Maritime Provinces into six groups, of which three are Mississippian and three Pennsylvanian. The use of the terms Mississippian and Pennsylvanian is more appropriate as regards major floral and tectonic events of the Acadian province than Lower and Upper Carboniferous. The former terms are not synonymous with the latter, for the Mississippian terminated in an early part of Upper Carboniferous time, as in the Mississippian valley region. The group subdivision established mainly on floral evidence is apparently the most natural one, for it is corroborated by tectonic events. Coal formation was not confined to one age as formerly assumed, but took place locally in the Pennsylvanian in each of the three ages represented by the groups of strata.

Nineteen other papers on geological and mineralogical researches were presented. Dr. Madeleine Fritz, Royal Ontario Museum of Palæontology, reported the recent discovery of the bryozoan species *Trachytoechus moniliformia* Fritz, n.sp. in the Gaspe sandstone of Lemieux Township, Gaspé County, in the interior of the Gaspe peninsula. This has provided evidence to substantiate the belief that the rocks in which the specimen was found are of Middle Devonian age. Dr. F. J. Alcock, of the Geological Survey of Canada, presented evidence based on the findings of several striated surfaces and many erratics in central Gaspe which support his already published conclusions that the Labrador ice sheet crossed the Shickshock Mountains. Dr. J. S. DeLury, professor of geology and mineralogy in the University of Manitoba, was elected president of the Section, and Dr. B. R. MacKay, of Ottawa, vice-president.

Dr. H. S. Jackson, University of Toronto, President of Section V, spoke on "Life Cycles and Phylogeny in the Higher Fungi". The discussion centred in a comparison of life-cycles in the rusts with those in the red algæ. It was shown that not only do the normal cycles correspond very closely, but that the same sort of simplified cycles occur in both groups. A life-cycle comparable to that of the ascomycetes also occurs among the simplified red algæ.

Prof. Velyien Henderson, the Flavelle Medal winner, presented a paper by invitation entitled "Studies in Anaesthesia with the Cyclopropane Group". Prof. A. T. Cameron, professor of biochemistry in the University of Manitoba, outlined the results of his researches on the relative sweetness of certain sugars and mixtures of sugar. If a solution

contains known concentrations of two or more sugars, a means has been found for calculating the sweetness of this mixture in terms of that of a specific concentration of sucrose or of glucose. It has been demonstrated that the sweetness of 25 per cent sucrose is not more than (and is probably less than) 3·3 times that of 5 per cent sucrose. Forty-three other papers on various phases of biological and medical sciences made up the programme of Section V. Dr. Robert Newton, president and formerly professor of plant biochemistry in the University of Alberta, is the new president of the Section and Prof. B. P. Babkin, research professor of physiology in McGill University, vice-president.

Prof. J. K. Robertson, professor of physics in the Queen's University, Kingston, Ontario, is the new president of the Society, and Prof. E. S. Moore, professor of geology in the University of Toronto, vice-president.

J. R. DYMOND.

# THE ROYAL OBSERVATORY, GREENWICH

## ANNUAL REPORT

THE annual report of the Astronomer Royal to the Board of Visitors covers the period May 1, 1943–April 30, 1944, and describes the work done during the year at Greenwich and the various out-stations which together constitute the war-time Royal Observatory. Until the last-named date, no further damage by enemy action had been sustained at Greenwich. On the observational side, a restricted astronomical programme on the Airy transit circle has been maintained, solar work has been continued on the photoheliograph and spectrohelioscope, and the routine meteorological observations have been made as in normal times. Work at the out-stations includes the maintenance and improvement of the time service, which still operates from two undisclosed locations, the rating and supply of chronometers and watches for use in H.M. Forces, the production of the *Nautical Almanac* and various ancillary publications, and the regular magnetic observations made, as in previous years, at Abinger.

Fundamental observations of position made on the Airy transit circle include about a thousand transits of stars, the sun, and the planets. Collimation observations, which have hitherto been possible only in daylight and then only with difficulty, are now facilitated by artificial illumination. A surprising feature revealed by the level observations of the last twenty-one years is that in that time the east pier of the instrument has steadily sunk by about $\frac{1}{12}$ in. relative to the west pier, though no such subsidence had occurred before in the seventy-two years of its previous history.

A discussion of the preliminary tests on the new reversible transit circle, based on observations made between its installation in 1936 and 1940, shows that the annual variations in level and azimuth are satisfactorily small. The diurnal changes in azimuth are small; those in level are of more consequence but can be reduced by better lagging of the piers; but those in collimation are disconcertingly large when the ambient temperature is unsteady. At present there seems no escape from the conclusion that a large amount of observing time must be used on observations of collimation in order to provide a satisfactory control of the variations. Latitude results on the Cookson floating zenith telescope relating to the period 1936–40 have also been derived, and the observations are examined with the view of tracing to their source the occasional large residuals shown, especially by recent observations. No certain conclusion is reached, though anomalous surface tension effects and wind effects are suspected.

The solar work calls for little comment. Sunspot frequency has slowly fallen, no spots being recorded at all during February, and only one very small spot during April. The epoch of minimum activity has apparently been reached, and the first high-latitude spots of the new cycle appeared in May 1943. Geomagnetic activity was considerable, however: one great storm and twenty smaller ones occurred, some of these latter falling in a 27-day cycle characteristic of storms at solar minimum. It is surprising that one of the five short-wave radio fade-outs which occurred during the year did so when no spot was visible on the disk. Fade-outs of this type have hitherto been attributed to solar flares ('chromospheric eruptions'), which are associated almost exclusively with sunspots. It will be interesting if positive spectroscopic evidence can be obtained that this is an instance of a flare occurring unassociated with a spot.

The Nautical Almanac Office continues its routine computational work involved in the production of the *Nautical Almanac*, the *Abridged Nautical Almanac*, the *Air Almanac* and the *Astronomical Navigation Tables*. A large increase in the work of the Office has occurred, and still more is forecast, as a result of the formation of the Admiralty Computing Service early in 1943. The Nautical Almanac Office forms the nucleus of this body, performing all the centralized computing and advising on tables, methods and machines. Some forty pieces of computation have been undertaken, none of them of an astronomical character, and about half of them have already been completed.

A major section of the Astronomer Royal's report is devoted to the work of the Time Department, which is evidently still expanding rapidly. The time service has been operated, as in previous years, from duplicate stations, each a self-contained unit itself capable of providing the whole service. The change-over from pendulum clocks to quartz crystal clocks, forecast in the last report, is now under way. Three quartz clocks have been installed during the year, one at each station being equipped with a phonic motor having a 60 : 61 gearing to provide the vernier time signals. These signals are now operated solely from phonic motors, and the accuracy of spacing of the signal pulses has greatly improved. Errors of as much as five milliseconds due to the unfortunate habit of pendulum clocks of 'wandering' between final correction and signal transmission have also been eliminated by this substitution. The new clocks are not yet used as primary standards, since the quartz crystals are not sufficiently 'aged', so the long-term performance of the time service has not yet been materially improved by their installation. But in short-term performance a marked improvement has already occurred: the uncertainty of individual 24-hour intervals defined by successive $10^h$ GBR signals has decreased from $\pm 5$ to $\pm 1{\cdot}2$ parts in $10^8$. Improvements in long-term performance are predicted for the near future as a result, first, of the transference to floating-battery operation of the primary standards maintained outside the Observatory (their performance has hitherto suffered from

mains failures); and, secondly, of the eventual incorporation among the primaries of the quartz clocks newly installed, and others to be installed, at the Observatory. After that, improvements in the time service will depend not so much on horological developments as on improvement of the astronomical observations. Although minor improvements are possible in the standard small transit instruments at present in use (an optical autocollimation method of level determination is mentioned), their supersession by a photographic reflex zenith tube is forecast by the Astronomer Royal, and preparations for the new telescope are already at the design stage. The Admiralty has sanctioned construction of an instrument of aperture 10 in. and focal length 11 ft. 3 in., giving a scale of 1 minute of arc to 1 mm., and the main details have already been settled. This instrument should improve materially the accuracy of the time determinations. Together with the purely horological developments reported and forecast in this report, it should make possible the provision in the future of a time service equal to all the exacting demands made upon it, and second to none in the world.

## CARNEGIE INSTITUTION OF WASHINGTON

### ANNUAL REPORT

THE Year Book No. 42 of the Carnegie Institution of Washington, covering the year July 1, 1942–June 30, 1943, includes the reports of the Executive Committee, the auditors, and of the president, together with reports of departmental activities and co-operative studies. The president's report points out that although the total research effort of the Institution is more than twice as great as in the year just prior to the War, the efforts of the research staff are now so largely devoted to war research that the regular programmes have been severely curtailed. The services of seventy members of the Institution staff have been loaned for war work in other organizations. The Geophysical Laboratory is now completely devoted to a war programme for which its facilities and staff are specially fitted, and the Department of Terrestrial Magnetism is similarly occupied. The Mount Wilson Observatory has several important programmes under way utilizing the special knowledge of astronomers and physicists, and the war effort continues to demand more outstanding talent in the physical sciences than is available and to utilize to a lesser extent men from the biological sciences.

Investigations of the Division of Plant Biology referred to in the report are those on the biochemistry of algæ, including the selection and isolation of algæ, their pigments, effects of environment on their pigment content, and the production of organic matter by *Chlorella pyrenoidosa*. Investigations on the nature of substances produced directly by photosynthesis in sunflower leaves have continued, and improved methods of pigment analysis have been developed which show promise of application to other fields of chemical and biochemical investigation. In addition to investigations on the breeding of new forage grasses of importance for food production, excellent progress is reported in the normal programmes of biochemical investigation and experimental taxonomy. In the Department of Genetics, research in endocrinology, especially in regard to the action of the parathyroid gland, is being completed, and an interesting mutation in mice which aids in interpreting certain processes of normal development is being studied. Other investigations concern broken chromosomes in maize, the genetics of the mouse, hormone action in carbohydrate and fat metabolism, the effects of ultra-violet radiation on mitosis, radiation theory and breeding studies on the Russian dandelion.

At the Mount Wilson Observatory the remarkable reversal of sign of magnetic polarity characteristic of a new solar cycle has been fully confirmed. Advances in the efficiency of the stellar spectrographs have led to notable discoveries regarding the structure of the expanding shells surrounding the novæ of our galactic system and have aided in the interpretation of these objects. The discovery of a shell round the novæ in Auriga of 1891 is of exceptional interest. The powerful spectrographs in use with the 100-in. telescope have opened new fields in the analysis of stellar spectra, and in the study of differential motions in the stellar atmospheres, and of the distribution and composition of the gaseous clouds of interstellar space. The cyclotron at the Department of Terrestrial Magnetism has been completed, and cosmic data were assembled and analysed to increase the understanding of solar geomagnetic and ionospheric relations and to improve the technique of short-term forecasting of ionospheric disturbances. The value of the ionospheric programme undertaken by the Department has been emphasized by the urgent need of particulars regarding the relations of ionospheric variations and disturbances and the many confidential studies for operational application which have been made. Tables of changes in the annual mean value of the geomagnetic field with sunspot cycle, the average annual variations, daily post-perturbations and average solar daily variations for the period 1905–42 were nearly completed.

The final section of the president's report considers the broad problem of the status of scientific research in the United States after the War and the unique position of the Institution. The importance of independent scientific bodies such as the Carnegie Institution in the pattern of scientific research likely to develop after the War is emphasized, and in a frank discussion of the probable endowment position of research generally as between the universities, the Government, and independent scientific institutions, the necessity of studying the trends carefully is stressed.

## *DROSOPHILA MELANOGASTER*

THE American fruit fly holds a unique position in biology; this animal has probably been more intensively studied from all angles of biology than any other. The immense literature and specialized language illustrates the intensity of attention it has received. Yet some geneticists, and a much smaller proportion of botanists and zoologists, know very little of the results of this intense experimentation. It was understandable that during its early years of captivity it should be of particular interest for the development of the chromosome theory of heredity. As a consequence the excuse that it was a laboratory plaything might be considered to be reasonable.

Since that time, however, this Drosophila has provided most important data in subjects which are considered to be the province of the taxonomist, ecologist and morphologist.

Its intrinsic value as an organism about which we know more of its heritable characters than of any other living thing gives Drosophila a position which cannot be ignored when discussing the evolutionary problems and behaviour of organisms in the wild. The 'drosophilists' have realized the importance of wild population studies and are providing and accumulating many data in the United States.

It is fortunate that two monographs have just been issued[1,2] under the names of the late Dr. C. Bridges and Dr. K. S. Brehme, and Prof. J. T. Patterson, respectively. The first is a valuable and possibly classical work on the known characters of Drosophila. After listing the symbolization used in Drosophila literature in a form comprehensible to an ordinary geneticist, the inherited characters are described, together with the positions of the related genes on the chromosomes, their origins and authorities. These data, included in two hundred pages, are followed by chromosome maps of the genes which leave all other published maps far behind. A fitting conclusion to the publication is the inclusion of the salivary chromosome maps originally published in the *Journal of Heredity*. The conception of this work was designed by Dr. M. Demerec, director of the Carnegie Institution, and with the co-operation of many geneticists the compilation by Dr. Brehme is a fitting memorial to Dr. Bridges. This publication gives the biologist an accurate description of the genetic characters of *Drosophila melanogaster*.

The publication by Patterson and his co-workers carries, as it were, the attack into the enemy's camp. Here the species of Drosophila which have been found in the south-west of the United States and Mexico are described with the meticulous care of the systematist, and each is illustrated with coloured plates. Twenty-four new forms are described for the first time, while numerous data from collecting work provides an insight into geographical distribution and reasons for the fluctuations in numbers in wild populations. J. T. Patterson and R. P. Wagner consider the distribution of the species of Drosophila throughout the United States and give data on the reactions of different species to ecological factors. L. J. Wharton describes the metaphase complements and the salivary gland chromosomes of eighty Drosophila species.

As a result of these investigations on an animal the genetical constitution of which is better known than that of any other, it is possible to raise doubts and to call for reconsideration of important current and established theories, some of which are keystones in branches of biology. For example, it is clearly seen that homology between parts of chromosomes in related species cannot be assumed without hybridization experiments and linkage studies. Similar characters in different species may depend on different genic origins. This being so, to what extent can homology of characters in different organisms be utilized as has been done in the past by morphologists as a criterion in evolution? Does the different origin and development of a character affect the validity of the evidence derived from analysing such characters in different phyla?

Again, there is strong evidence in Drosophila that phylogenetic relationships based on metaphase chromosome idiograms may be invalid unless supported by salivary gland chromosome analysis or cross-over configurations and other genetical criteria.

On the problem of speciation, the distribution of the species of Drosophila in the United States is interesting. A very few species are widespread while a larger number of species, many of which are local, are found in areas where there is great environmental diversity.

The reviewer is impressed by the painstaking work, the absence of contentious or other theories and the manner in which the solid results become related into a coherent whole. The evidence touches on many fields of biology and it is salutary, and we believe necessary, to consider it in relation to current theories in different branches of botany and zoology.

F. W. SANSOME.

[1] Bridges, C. B., and Brehme, K. S., "The Mutants of *Drosophila melanogaster*", Carnegie Institution of Washington Pub. 552 (1944).

[2] Patterson, J. T., "Studies in the Genetics of Drosophila III", University of Texas Pub. 4313 (1944), 2.50 dollars.

## SUMERIAN MYTHOLOGY*

TO-DAY everyone in the least interested in archæology has heard of the Sumerian culture of Mesopotamia and the cuneiform system of writing that was developed there. Not everyone realizes that only so recently as 1850 was the existence of this all-important non-Indo-European and non-Semitic people so much as suspected. Nowadays, of course, the Sumerians take pride of place as the dominant cultural element in Mesopotamia from the fourth to nearly the beginning of the second millennium B.C., and the influence of their culture is known to have spread far and wide and to have lasted long after the folk themselves had been swamped by their Semitic neighbours. Why are there to-day sixty seconds in a minute, sixty minutes in an hour, and $6 \times 60$ degrees in a circle? Because the Sumerians used a unit of sixty. Their unit of weight, the mina, seems to have been just about equal to the Imperial pound.

The Sumerians used tablets of clay to write on, and many thousands of these have turned up in the course of excavations. More particularly is this true of the American excavations at Nippur, which were carried on at intervals between 1889 and 1900. But the writing is difficult to interpret and much of the material is broken; and in consequence a great deal still remains to be deciphered. Most of the quarter of a million or so tablets that have been unearthed are concerned with matters of business, but a small proportion, dating mostly to about 2000 B.C., can be classed as 'literary' tablets, and these are inscribed with Sumerian epics, myths, hymns, lamentations, proverbs and words of wisdom. There are also a number inscribed with mathematical texts and incantations Mr. S. N. Kramer is concerned to publish much of this hitherto undeciphered material in a number of volumes, of which this one on Sumerian mythology is the first. He has had the opportunity of working for nearly two years at the Nippur collections now in Turkey, as well as at those from the same site now housed in the United States. This first volume is extremely well put together and illustrated. It does not assume a greater knowledge of Mesopotamian

* Memoirs of the American Philosophical Society. Vol. 21: Sumerian Mythology, a Study of Spiritual and Literary Achievement in the Third Millennium B.C. Pp. xiv+125+21 plates. By S. N. Kramer. (Philadelphia, 1944.)

archæology than can be obtained from any one of the well-known manuals.

After an explanatory preface and an introduction there is a chapter on the scope and significance of Sumerian mythology. This is followed by an account of the myths of origins, of Kur and the slaying of the dragon, of the deluge—antedating, of course, the well-known Neo-Babylonian epic—of the marriage of the god Martu, and of the preference of Inanna, sister of the sun-god Utu, for the farmer-god Enkimdu over the shepherd-god Dumuzi: a pretty story which ends with the seeming victory of Dumuzi over Enkimdu.

These Sumerian 'literary' tablets are some centuries older than the Neo-Babylonian epics, and borrowing by these can be detected. They are also about six hundred years older than the somewhat similar material which is turning up at Ras Shamra in northern Syria. Contact in Mesopotamia between the intrusive, matter-of-fact Sumerian folk of unknown racial affinity and their Semitic neighbours seems to have resulted in the development of epics, myths and proverbs which have proved a veritable mine into which later cultures have delved when they in turn set themselves to answer such problems as the origin of the world and man. It is to be hoped the subsequent volumes will appear without undue delay. M. C. BURKITT.

## FORTHCOMING EVENTS

### Tuesday, September 5

WOMEN'S ENGINEERING SOCIETY (MANCHESTER BRANCH) (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. E. T. Norris: "The Moving Coil Voltage Regulator".

### Friday, September 8

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Harold Spencer Jones, F.R.S., and Mr. R. T. Cullen: "The Division Errors of the Reversible Transit Circle of the Royal Observatory, Greenwich"; Mr. C. S. Beals: "Some Results of a Spectrophotometric Study of the Wolf Rayet Binary HD 193576"; Mr. D. L. Edwards: "Periodic Changes in $\gamma$ Cassiopeiae during the past 100 Years".

## APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

UNIVERSITY READERSHIP IN PHYSICS tenable at King's College—The Academic Registrar, University of London, South Kensington, London, S.W.7 (September 6).

HEAD OF THE DEPARTMENT OF PRODUCTION ENGINEERING—The Principal, Leicester College of Technology and Commerce, Leicester (September 9).

LECTURER IN CHEMISTRY—The Registrar, Technical College, Sunderland (September 9).

CHIEF ENGINEER by large firm of Locomotive Manufacturers—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2243.XA) (September 11).

SPEECH THERAPIST—The Director of Education, Education Offices, 15 John Street, Sunderland (September 15).

TECHNICAL EDITOR of the *Electrical Power Engineer* and DIRECTOR OF STUDIES of the Correspondence Tuition Scheme of the Association—The General Secretary, Electrical Power Engineers' Association, 102 St. George's Square, London, S.W.1 (endorsed 'Technical Editor') (September 15).

UNIVERSITY READERSHIP IN CHEMISTRY tenable at the Royal Cancer Hospital (Free)—The Academic Registrar, University of London, South Kensington, London, S.W.7 (September 18).

RESPONSIBLE LECTURER IN PHYSIOLOGY—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3 (September 20).

CHAIR OF MINING—The Acting Registrar, The University, Leeds 2 (September 30).

DIRECTOR OF RESEARCH, Forest Products Research Laboratory, Princes Risborough—The Secretary, Department of Scientific and Industrial Research, Teddington, Middx. (October 9).

LECTURER IN PHILOSOPHY—The Very Rev. the Dean, Christ Church, Oxford (October 15).

DIRECTOR OF THE DEPARTMENT OF SOCIAL STUDIES, University of Sydney—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (Sydney, December 1).

SECOND VETERINARY OFFICER at the Imperial Bureau of Animal Health, Weybridge—The Secretary, Imperial Agricultural Bureaux, 2 Queen Anne's Gate Buildings, London, S.W.1.

ASSISTANT MASTER (temporary) qualified to teach ENGINEERING SUBJECTS and MATHEMATICS up to Ordinary National Certificate standard—The Principal, Technical Institute, Beckenham Road, Beckenham, Kent.

BOTANIST AND ORGANIC CHEMIST to the Nyasaland Research and Development Co., Ltd.—Dr. M. Nierenstein, 2 Rylestone Grove, Bristol 9.

## REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

Pitt Rivers Museum: University of Oxford. Occasional Papers on Technology, 1: The Manufacture of a Flint Arrow-head by Quartzite Hammer-stone. By Sir Francis H. S. Knowles. Pp. 38 (6 plates). 5*s*. Report of the Curator of the Pitt Rivers Museum (Department of Ethnology) for the Year ending 31 July 1943. Pp. 6. (Oxford: Pitt Rivers Museum.) [88

Tory Reform Committee. Bulletin No. 5: What Shall We Use for Money? Pp. 16. (London: Tory Reform Committee.) [88

A Scientific Policy for British Agriculture (particularly in relation to Nutrition). Pp. 16. (London: Parliamentary and Scientific Committee.) 9*d*. [108

Ministry of Fuel and Power: Committee on the Efficient Use of Fuel. Fuel Efficiency Bulletin No. 32: Fuel Economy at Collieries, with particular reference to Compressed Air. Pp. 17. (London: Ministry of Fuel and Power.) [108

Institution of Gas Engineers. Communication No. 269: The Gas Industry; some factors affecting Future Development. Pp. 56. (London: Institution of Gas Engineers.) [148

Royal College of Physicians of Edinburgh. Annual Report by the Curator of the Laboratory for the Year 1943. Pp. 12. (Edinburgh: Royal College of Physicians of Edinburgh.) [218

The AScW and other Bodies. Pp. 8. (London: Association of Scientific Workers.) 3*d*. [218

British Rubber Producers' Research Association. Publication No. 49: Rubber, Polyisoprenes and Allied Compounds, Part 7: Action of Nitric Oxide Thereon. By G. F. Bloomfield and (in part) G. A. Jeffrey. Pp. 6. (London: British Rubber Producers' Research Association.) [218

### Other Countries

Smithsonian Institution: United States National Museum. Bulletin 185: Checklist of the Coleopterous Insects of Mexico, Central America, the West Indies and South America. Part 1. Compiled by Richard E. Blackwelder. Pp. xii+188. (Washington, D.C.: Government Printing Office.) 35 cents. [257

Department of Transport, Air Services Branch: Meteorological Division. Meteorology of the Canadian Arctic. Pp. iv+85. (Ottawa: Department of Transport.) [257

U.S. Department of Agriculture. Technical Bulletin No. 866: Nature and Extent of Mormon Cricket Damage to Crop and Range Plants. By Ralph B. Swain. Pp. 44. (Washington, D.C.: Government Printing Office.) [267

Annals of the Carnegie Museum. Vol. 30, Art. 5: A New Terrestrial Vulture from the Upper Eocene Deposits of Wyoming. By Alexander Wetmore. Pp. 57–70. Vol. 30, Art. 6: Another New Boa of the Genus Epicrates from the Bahamas. By M. Graham Netting and Coleman J. Goin. Pp. 71–76. (Pittsburgh, Pa.: Carnegie Museum.) [267

Smithsonian Institution: Bureau of American Ethnology. Bulletin 138: Stone Monuments of Southern Mexico. By Matthew W. Stirling. Pp. vii+84+62 plates. 35 cents. Bulletin 141: Ceramic Stratigraphy at Cerro de las Mesas, Veracruz, Mexico. By Philip Drucker. Pp. viii+95+58 plates. 50 cents. (Washington, D.C.: Government Printing Office.) [277

Transactions of the American Philosophical Society. New Series, Vol. 33, Part 3: Infectious Anemias due to Bartonella and related Red Cell Parasites. By David Weinman. Pp. 241–350. (Philadelphia: American Philosophical Society.) 1.25 dollars. [277

Uganda Protectorate: Forest Department. Annual Report for the Year ending 31st December 1943. Pp. 8. (Entebbe: Government Printer.) 1*s*. [317

Proceedings of the California Academy of Sciences, Fourth Series, Vol. 25, No. 2: Relations of the Temperate Floras of North and South America. By Doughton Houghton Campbell. Pp. 139–146. Vol. 25, No. 3: *Pugillus astragalorum* Alter. By R. C. Barneby. Pp. 147–170+plate 17. Vol. 25, No. 4: Sublittoral Marine Algae of the Monterey Peninsula. By Prof. Gilbert M. Smith. Pp. 171–176. Vol. 25, No. 5: The Gander Oak, a New Hybrid Oak from San Diego County, California. By Carl B. Wolf. Pp. 177–188+plates 18–19. Vol. 25, No. 6: The Genus Drymaria in, and adjacent to, the Sonoran Desert. By Prof. Ira L. Wiggins. Pp. 189–214+plates 20–22. Vol. 25, No. 7: Water and Plant Anatomy. By Prof. George J. Peirce. Pp. 215–220. Vol. 25, No. 8: A Pleistocene Flora from the McKittrick Asphalt Deposits of California. By Prof. Herbert L. Mason. Pp. 221–234+plates 23–44. (San Francisco, Calif.: California Academy of Sciences.) [317

Jamaica. Annual Report of the Department of Agriculture for the Year ended 31st March 1943. Pp. 20. (Kingston: Government Printer.) [317

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium, Vol. 29, Part 1: Taxonomic Studies of Tropical American Plants. By C. V. Morton. Pp. xi+86. (Washington, D.C.: Government Printing Office.) 25 cents. [317

U.S. Department of Agriculture. Circular No. 675: Control of the Mexican Bean Beetle in Irrigated Districts in the West. By R. L. Wallis. Pp. 12. (Washington, D.C.: Government Printing Office.) [317

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# NATURE

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## CONTENTS



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# SCIENTIFIC AND INDUSTRIAL RESEARCH.—III

IN the conception of the strategy of research which we have thus far developed, the first place has been given to the supply of research workers of the type required to serve the needs of the broad programmes of research contemplated. We have stressed the need for creative and imaginative minds, and in considering the functions of the universities in training such workers, it was recognized that while specialists are essential they may have to take their place in team-work, and that freedom of research requires that the specialist should be competent to move freely across the compartments of science which are at present imposed by the teaching and organization of science. Further, it was recognized that provision must be made to assist in bringing to the fore directors or managers of research of the requisite calibre.

We have now to consider more fully the tactics by which these requirements can be further fostered and developed. Admittedly, in referring to the question of leadership, we have already entered the domain of tactics: the provision of senior fellowships of research is a matter of tactics, whether we view it from the point of view of facilities and organization for research or of encouraging the development of men of the right type for responsible positions in the direction of research. There are, however, two points to be noted here before proceeding to consider the question of tactics in general.

It is, however, no part of the strategy of research to provide directly for the leaders required, any more than it is the function of the universities. It is necessary to emphasize this in view of the tendencies in the recent report of the British Association Committee on Post-war University Education and elsewhere to suggest that the universities are forcing-houses for leaders, either in industry or in other spheres. It is true that it is desirable that a larger proportion of the leaders of industry, for example, should spring from those whose training qualifies them to appreciate and appraise the scientific or technical factors in a situation or problem. It is true that the training the honours graduate in science receives takes little cognizance of such matters as social and ethical values. To urge that this situation should be improved, however, is not to suggest that the universities should change their functions or that they should depart from their tradition of imparting exact scholarship, and training those skilled in the special knowledge and technique that scholarship demands. It is to urge that such training should be based on a wider education, and that the educational system should be such that there are no impediments to originality and to those who possess creative and imaginative minds. It is with education at the pre-university level that we are concerned here, and this is the aspect that brings the educational system and policy of the country as a whole into the purview of research strategy. There could be no more fatal blunder than to introduce into the selection of scholars for the universities other

considerations than those of intellectual ability, originality and independence of mind, so far as these can be assessed.

We would not imply that character is not important. Rather, if the conditions at university and secondary school are right, it will be developed as a matter of course. But its selective influence will make itself felt when the graduate enters the larger world, in so far as its importance is recognized by the community, just as physical fitness is recognized as important. We cannot tolerate conditions at the universities of Britain which would lower the moral and physical standards of the community, and it is right that in our replanning of the universities, past neglect should be repaired. But it remains true that their prime preoccupation should be with the training of the mind and with the maintenance of high intellectual standards, not of mere book learning, but of scholarship, the capacity to think clearly, to weigh evidence, to handle knowledge effectively.

Granted then that the educational system of Britain has been re-organized and the university system expanded to provide industry and the nation as a whole with the right type of men and women for positions of research, administration and production adequate to the present needs, we have to consider next the tactics by which both the supply and the quality are to be maintained. These are the matters with which in the main the recent statement from Nuffield College is concerned, though a good deal of the same ground is covered by the subsequent report of the Association of Scientific Workers.

The first point to which attention should be directed here is that which has been repeatedly emphasized since the debates on scientific research in the House of Lords last year. If we are to be assured of an adequate supply of the right type of men and women for research and for like positions where scientific knowledge is required, the conditions of service must be sufficiently attractive. This must apply not merely to positions in industry and in Government departments but also in the universities themselves. The close relation between research and teaching in the universities, which has rightly been stressed, means that there must be a reasonable balance between standards of remuneration and status in both teaching and research posts. Again, from the point of view of research itself, maintenance of the highest standards of teaching makes it essential that the salaries and status of university teaching appointments should compare favourably enough with conditions elsewhere to attract to such work a sufficient proportion of the ablest minds of each generation.

These points are well brought out in the Nuffield College statement, which in general terms supports the more specific proposals which have been advanced by the Association of University Teachers and the Association of Scientific Workers for regrading and for a more adequate scale of salaries for university appointments. Improvement of the low standards which at present obtain in university appointments in this respect is in fact now generally recognized as a tactical measure of the first importance, but the magnitude of the scales must be determined as part of a general policy of rendering a scientific career, especially in research, more attractive. Nor can we separate consideration of salary scales from the consideration of other conditions which affect the attractiveness of a scientific career to men of outstanding ability.

Other conditions may also be considered broadly both from this point of view of making the career of research or of teaching sufficiently attractive to the best minds of each generation, and from the other point of view of making the best possible use of such ability when a scientific career has been chosen. Failure to attend to this second aspect would in fact not only soon render such careers less attractive to the ablest workers and adversely affect recruitment but would also lead to the steady loss of such workers by transfer to other occupations which they found more congenial and where their ability had fuller scope. For this reason it is important that the immediate demands for research workers, and the necessity for increasing university staffs so as to ensure that they have adequate time for teaching and for research, particularly in the newer universities, as the Nuffield College statement notes, should not lead us to overlook the question of keeping some reasonable balance between supply and demand. Violent fluctuations in this respect, with consequent intermittent and perhaps widespread graduate unemployment, can have a very detrimental effect on recruitment. The dangers in this respect to which Mannheim has directed attention and which were stressed again by Mr. Roy Glenday in his recent book should not be ignored. Some attempt on the part of industry and of other institutions to formulate as quantitatively as possible over a period of years the requirements for scientific and other academically trained personnel would be a tactical measure of first-class importance.

It has been recognized elsewhere that there is waste of scientific ability because of its deflexion to administrative or other duties which might be carried out by others not possessed of the same order of scientific ability. The report of the Association of Scientific Workers rightly directs attention to the handicap which an inadequate staff of laboratory technicians may place upon the research worker at the universities. It should be a cardinal point in our post-war short-term policy at least to see that the training of a sufficient number of such technicians is expedited so as to secure the fullest possible use of the services of the first-class scientific ability already available in our research laboratories both in the universities and elsewhere.

This point was particularly well put by the Parliamentary and Scientific Committee in its report on "Scientific Research and the Universities in Post-War Britain". The Nuffield College statement, however, makes the further point that apart from the necessary increase in trained scientific personnel —which may be a process occupying a considerable time—much more could fruitfully be spent in equipping existing research workers with more adequate resources, and high priority should be given to this. Proposals regarding technical services advanced by the Association of Scientific Workers in respect of

the larger universities obviously represent a need by no means confined to the universities themselves.

Equipment for research, either at the universities or elsewhere, is not only a matter of priority, but may well prove a matter enforcing co-operation and co-ordinated planning of research at the universities and at centralized research institutes of the type of the Massachusetts Institute of Technology, as Sir Alfred Egerton has urged.

Here, however, we are concerned primarily with questions of personnel. Next to questions of adequate remuneration and equipment may be placed those of status. It is important to remember that if we would avoid the waste of scientific ability on administrative duties, which in point of fact a research worker of outstanding ability may be ill-qualified to discharge, this is not to imply that his status as a scientific man should be regarded as a bar to promotion to administrative positions. It is of the utmost importance that there should be no such disqualification where a scientific worker shows himself possessed of high administrative ability; but it is equally important that means should be found of encouraging the outstanding research worker while he continues to do the research for which he is best qualified, without wasting that ability by transferring him to a position of higher status in which his ability is less effectively used.

Closely linked to this question of status is that of freedom of investigation and of publication. It is for such exceptional men that it is important to preserve the maximum freedom of investigation which Prof. A. E. Trueman stresses in "Science and the Future". It is worth considering whether, and if so, in what ways, the outstanding investigator might not be rewarded by the higher responsibility which is implied by allowing him to choose his own problem and tackle it in his own way.

The question of publication may be equally important, though this has received less attention except perhaps in the report of the Federation of British Industries Industrial Research Committee. But apart from the question of status or incentive, which is bound up with this question, publication of the scientific aspects of a research is important from the point of view of research itself as well as of the scientific worker. The advancement of science depends on the fullest possible publication of research, and Lord McGowan's words on this point in his address on "The Future of the Chemical Industry" last October are particularly welcome, in view of the contrast in this respect between the practice and outlook of industry in Great Britain and in the United States. Strong support for a more liberal policy of publication has also been forthcoming from Mr. Samuel Courtauld, who advocates the maximum degree of publication consistent with reasonable safeguards against abuse as the best policy for accelerating the healthy growth of every industry based on applied science. Such a policy would simultaneously remove the disadvantage of scientific workers in industry to which Lord McGowan referred, and to that extent increase the attractiveness of an industrial career in research.

Thus far we have been considering conditions of service mainly from the point of view of making a scientific career, especially in research, as attractive as possible to the ablest workers. We have now to consider factors which will promote the most favourable conditions for creative work, and will maintain or even enhance the originality and individuality which we have been at pains to recruit. The value for this purpose of close contact between teaching and research has been recognized, and much the same considerations apply to the promotion of closer relations between research workers in academic and industrial research.

Interchange and mobility of research workers is an invaluable stimulant to freshness of outlook and new ideas, and the Nuffield College statement devotes an important section to the consideration of this problem. Increase in the mobility of research workers, whether between one branch of industry and another, or between industry and the universities or Government departments or vice versa, is not only essential to ensure the best possible distribution of the available supply of research workers, but is also a stimulant to creative thought and the corporate attack on common problems, and especially borderline problems, the value of which it is almost impossible to estimate. Moreover, it is important to note that this should be a two-way traffic. As the Nuffield College statement indicates, there should be systematic provision for research workers engaged in industry to return to the university or to spend a period at a specialized research centre, both to keep their fundamental equipment up to date and to derive refreshment from day-to-day contact with colleagues engaged in other fields of research.

The senior fellowships in science established by Imperial Chemical Industries, Ltd., are one means by which such interchange may be fostered. Joint research councils of the type recently established by the University of Manchester and the Manchester Chamber of Commerce may well develop other means for associating industrial research workers with their local university colleagues. Clearly such measures must also bring academic workers into closer contact with the industries most closely allied to their special branches of work.

The adjustment of conditions of work so that they are more comparable in the different fields is one means of facilitating such mobility and interchange; but one of the most important is the institution of a common system of superannuation, as the Nuffield College statement suggests. Such a system, applying to research workers in all types of institutions, including workers in universities, Government research stations and research associations, technical colleges and polytechnics and scientific workers employed in industry, would, by the adjustment of existing methods of superannuation, make it possible for research workers to move from university work to industry, or to work under Government or a local authority, or vice versa, without any loss of pension rights. Extension of this system to cover the countries of the British Empire would facilitate the interchange of scientific men over the Empire as a whole,

while clearly such arrangements as those between the Imperial College of Science and Technology and the Massachusetts Institute of Technology for the regular interchange of staff and postgraduate students should be encouraged in this and in every possible way.

One such means, particularly at the universities, is the sabbatical year recommended by the University Grants Committee, as enabling scientific workers to give undivided attention to research problems for a long period or to travel and exchange experience with colleagues in other laboratories at home and abroad. This principle is strongly supported by the Association of Scientific Workers in its recent report; and it was noted as one for inquiry by Sir Ernest Simon in his pamphlet on the "Development of British Universities". That was also the note struck by Bruce Truscot in a suggestive discussion of the whole question in which he suggested that adoption of such a project might be premature until some other academic and financial reforms had been effected. The importance of timing in tactics should never be overlooked; but in the meantime, in addition to suggesting that, as a privilege, leave of absence might be asked for and given much more than it is, Bruce Truscot indicates two directions in which the practice might be extended. First, exchange professorships, both within the British Isles and between Great Britain, the Dominions and the United States should be encouraged and so far as possible arranged by a central organization representing the whole of the British universities. Secondly, he suggests the granting of leave purely for purposes of original work and investigation, subject to adequate control.

The second suggestion, in particular, is one that should also be explored by Government departments and by industry, for there is no room for doubt as to the value of such interchanges and wider contacts. There is, however, a further point in regard to the easier interchange between industry and the universities discussed in the Nuffield College statement which deserves to be noted. This is concerned with the subjects of investigation in such interchange between industry and the universities, and bears particularly on the question of freedom of science and of publication. It is argued by some that universities should avoid all association with industrial research of which the results cannot be freely published and made generally available. This attitude is taken up in regard to work being done wholly or partly in a university laboratory, both on the ground that scientific work at the university ought to be carried on without any profit motive and that secrecy always interferes with the free interchange of ideas among the research workers, and creates the wrong atmosphere both for fully successful fundamental research and for teaching.

If that objection is well founded, it merits serious attention in this connexion, for the whole object of our tactics is to create the atmosphere in which research can be most fruitfully carried on and in which originality and creative thought are fostered. It is plainly undesirable, as the Nuffield College statement points out, that the universities, the primary task of which is to combine disinterested research designed for the advancement of knowledge with teaching work of a high standard, should to any considerable extent allow themselves to be diverted to work which they would not undertake on its own merits. That may be unlikely to happen, but it is against the interests of industry itself to allow the fundamental research at the universities to be neglected or impeded.

It is therefore necessary from the point of view of personnel as well as of organization to exercise caution in using university laboratories or research workers for applied research which would involve any restrictive conditions or slackening in the pursuit of science. The danger may perhaps be overstressed. It should be possible to second a university research worker for such work for a period, as difficulties are fewer when the work is not undertaken in a university laboratory. Moreover, while it is right to guard against the danger of university departments falling too much under the influence of particular firms or industries, to the detriment of their main tasks, we must not limit the pursuit of applied science in university institutions where this arises naturally out of the more fundamental work and can be carried on with full freedom to discuss the problems and to publish the results.

Possibly the best solution of this problem will be found along the lines suggested by the Nuffield College statement. If there were a general code of conduct recognized as applicable to university scientific workers undertaking outside industrial work for private firms, it would be a comparatively easy matter to work out a special code to cover these problems. With easier interchange between the different branches of research and a clear code of professional conduct, transfers would present far fewer difficulties than in the past, and a two-way traffic between the universities and industry could be fruitfully established without some of the professional complications which at present arise.

The entire problem is obviously one to be tackled jointly by the universities, professional associations and industrialists, and it is one in which the initiative might well come from the professional associations of scientific workers. Indeed, it would be difficult to exaggerate the importance of the contribution which such associations might make in this field of tactics which we have here been considering. Admittedly, the responsibility for executive action will rarely lie with them, but without their advice and co-operation the right atmosphere and the appropriate conditions for the most fruitful research are unlikely easily to be worked out. However firmly the universities hold to their own highest traditions of disinterested inquiry, however far they succeed in establishing conditions where research can be carried out at leisure and free from financial worry or embarrassment, however much there and in industry the spirit of service to the community adds an incentive to that of the quest for truth, the co-operation of professional associations will still be required. It must be admitted that in the past such associations have been slow to recognize their opportunities or their wider responsibilities.

# MEDICAL EDUCATION IN GREAT BRITAIN

THE report of the Inter-Departmental Committee on Medical Schools, of which Sir William Goodenough is chairman, is summarized on p. 322 of this issue. The report itself must be read if the Committee's recommendations are to be fully understood. Some of them involve considerable changes in outlook and teaching in both the schools and universities of Britain; others profoundly concern the general public; yet others will hearten the reader and lead his thought beyond the technical details of medical education. For medical work must always be closely bound up with the structure and work of society, and the medical practitioner has to play an important part in social evolution. Any serious consideration of his training must therefore be just what this report is—a sociological as well as a medical document. Several of the reforms which it proposes are similar to, if not identical with, the reforms recently suggested by the Planning Committee of the Royal College of Physicians (which were summarized in the *Lancet*, 607; May 6, 1944, and the *British Medical Journal*, 668; May 13, 1944), so that the views of these two committees can be considered together. In both, the inevitable interaction between scientific method and the older ideal of the art of medicine is evident, and both reports seek to preserve the best elements of the two methods of approach to the patient. Both emphasize the future need to ensure the maintenance of health rather than to await the onset of disease.

The recommendations of the Goodenough Report have the support of "the vast majority of those who are responsible for and engaged in medical education and research in all parts of Great Britain". They must therefore carry great weight. This report points out that, while some of its recommendations could be introduced during this War, others need time to mature. Even if this were not true, doctors cannot be quickly produced, and both the reports under consideration should be read by those who are confronted with the very urgent need for large numbers of doctors in India (see *Nature*, 658; May 27), and elsewhere. In the U.S.S.R., where the need has been, and still is, urgent, a system based on the idea of industrial 'shifts' has been utilized. It is good to know that the Goodenough Committee, which is able to plan for a country in which the need is less insistent, prefers quality to rapid production. Wide publicity should be given to its firm statement that medical schools should regard themselves as under a definite obligation to do all in their power to meet the need for more doctors, but that they should not take in more students than they can train properly. This Committee urges that, in order to shorten the time lag between the initiation of the reforms which it proposes and the production of their results, action should be taken as soon as possible to create postgraduate courses for practitioners, to build up an adequate supply of teachers, and to assist medical schools by means of financial grants, priority of building materials and labour, and so on, and by provision of adequate staffs, accommodation and equipment. But the Committee also urges that all its recommendations should be initiated as soon as possible, because the success of many schemes of non-medical post-war development will depend upon an adequate supply of doctors who have the right training and outlook. Greatly increased financial support from public funds will be required if we are to secure a sound foundation for national health. The total capital expenditure that should be incurred may amount, within ten years, to ten million pounds at pre-war costs, and recurrent grants will have to be increased until they total, after ten years, three or four million pounds a year at pre-war values. These increases in recurrent grants would thus represent, after ten years, only 2 per cent of the estimated cost, in the first year, of the national health service. It will be agreed that this is a "reasonable price for the community to pay for a service which is vital to the promotion of national health".

As the Goodenough Report says, "Properly planned and carefully conducted medical education is *the* essential foundation of a comprehensive health service". The Committee thinks it advisable to stress this point, because current discussions of a health service show signs of premature concentration on the detailed structure of such a service and neglect of its essential foundation, and because problems of medical education and research are not the exclusive concern of the medical schools and the medical profession. The general public should maintain a lively and understanding interest in them. The doctor of the future will, the report suggests, become the adviser on the health of both the individual and the community, and will have the responsibility of ensuring one of the principal aims to which national policy is being directed, namely, the achievement by everyone of the highest possible standard of physical and mental health. This is but a modern statement of that spirit of service which has been at all times the distinguishing mark of the medical man.

While the nation can, the Goodenough Committee thinks, rightly be proud of British medical practice and education as it is, the doctor has not been adequately trained in the past to shoulder his new responsibilities for national health. He has studied disease itself more than the promotion of health—and disease chiefly as it is seen in individuals. He has been taught, as the *British Medical Journal* (648; November 20, 1943) pointed out, too much about how people die and too little about how they live. One of the basic proposals of the Goodenough Committee is that emphasis must be placed throughout the whole of undergraduate and postgraduate medical training on a sound knowledge of how to produce and maintain a healthy nation. This is made clear in the section of the report devoted to social medicine. A new orientation of medical education is required to give effect to this general idea. It involves a big expansion of the social work of hospitals and radical changes in the outlook and methods of most of the teachers. The developments discussed in this

section on social medicine will interest the layman profoundly.

The layman will be no less interested in the chapters of the report devoted to child health, maternity and psychiatry. Better provision for the welfare of children and their mothers will have to extend beyond the sphere of medicine; but doctors will have to play a leading part in them. In general, the teaching about children and their mothers has not been adequate, and proposals are made to remedy this deficiency. If, moreover, the doctor is to grasp modern conceptions of disease or to treat some illnesses properly, he must have better instruction in the normal and abnormal working of the human mind. Every medical school ought therefore to have a department of psychiatry, the work of which should be related to that of other departments. The supply of teachers for these departments also is inadequate, and their training is an urgent need.

In their discussions of all these matters the two reports under consideration agree in main principles. Both also express similar views on the necessity of teaching principle and method rather than fact, especially during the early training of the medical student, on the requirement that at least a year should be spent in a resident hospital post, on the need for drastic reorganization of the medical curriculum with a concomitant reform of the examinations held, on revision of methods of selecting medical students and on the need for adequate training and remuneration of the teachers of medicine and for the betterment of the position of the clinical teacher.

The Committee of the Royal College of Physicians proposes that all university fees should be abolished—a proposal which is not so revolutionary as it sounds when we remember that, as the *British Medical Journal* has reminded us (665, May 13), the present fees paid cover only about one third of the cost of the education given. The Goodenough Committee does not go so far as this. It is not, indeed, within its terms of reference to consider university fees in general. But it makes proposals for the financial maintenance of the medical student throughout his whole training and others for the supervision of his health, housing and recreations which go much further than mere remission of fees. If they are adopted, no parent, however meagre his means, need hesitate to launch his son or daughter upon the varied adventures in public and private service which medicine makes possible; nor need he worry about his child's health or future opportunities. The daughter, moreover, would no longer have to run the risk of exclusion by the medical schools. Co-education of men and women would be universal and Exchequer grants could be withheld if reasonable numbers of women were not admitted.

This question of the selection of the prospective medical student would seem, indeed, to be the keystone of the recommendations of both these committees. For both insist that the right kind of student must be obtained at the very beginning and that all classes of society must be enabled to provide candidates for medicine. Both committees further insist that the medical student's character and personality must be adequately considered when he is being selected. Both dislike selection by examination alone, because this favours undesirable specialization at school and thus may prejudice that broad school education which the doctor especially requires.

Whatever the decision may be about the necessity or otherwise of a selecting examination, it is clear that the task of interviewing every candidate for admission to our medical schools would be a formidable one. It would not be easy to make sure that the interviewers created and maintained in the future a uniform standard of selection all over the country. They would have to interview, the *British Medical Journal* (655; May 13) states, some 2,500–5,000 prospective students every year; and, if the number of doctors is going to increase considerably, as the Goodenough Committee suggests that it will, this task of interviewing would increase in proportion. Nor will everyone feel disposed to give the school record too large a share in the selection of our future medical men. The real characters and abilities of boys and girls are not always discernible at school; they can also be easily misunderstood by some interviewers who may have nothing to guide them but what they can learn at a single interview, together with a school record of doubtful value and perhaps the opinions of a school teacher who, however able he may be, must often, especially in large schools, imperfectly understand some of his pupils. Both school teacher and interviewer might easily fail to discern abilities which, even if they did not fit a pupil to become a good medical practitioner, might help him to do good work in other fields of medicine.

The humble potential patient in all of us may be even more doubtful of tests of intelligence or aptitude which might, it is suggested, help in the selection. It will not be surprising, indeed, if many readers of these reports reject all the arguments which would seek to reduce the importance and efficiency of that popular scapegoat, the examiner. They may not wish to adopt the desperate remedy once proposed by no less an authority on the human mind than William McDougall, namely, examinations for the selection of examiners; but they may suggest that examinations can be altered and that it should not be an insuperable task so to modify the university entrance examination—which is the standard of entry to medicine required by the Goodenough Report—that it would at any rate help to select the qualities required in the medical student. It might even turn out that the main faults of the examination system lie not in the system itself, but in the type of questions asked and especially in the practice of allocating marks by number. If the selecting examination included an oral examination, which should, so many experienced examiners think, be a feature of all examinations, because it gives the candidate a golden opportunity to reveal just those qualities which cannot be expressed on paper or in a practical test, this could be made the occasion of the interview desired by these two reports.

Taking it by and large, the layman who is to be treated when he is ill by the future doctor may prefer that the character and personality of the medical

student should not be accorded too high a value when he is being selected at the outset of his career by individuals who may never, even if they happen to be specially qualified psychologists, assess them correctly. In any event, these qualities will develop during a course of training which should, if it is properly designed, eliminate the misfits and direct them to more suitable work. The Goodenough Committee, in fact, specifically proposes that there should be means of eliminating such misfits as early as possible in their undergraduate careers. Selection can, in other words, be imposed too early, and the value of the natural selection of the medical school and the hospital can be under-estimated. This is especially true of the medical student, who cannot possibly know, until he begins to handle patients, whether he either wishes to be, or is fitted to become, a practising doctor. It would therefore seem to be wiser to emphasize selection at a later stage of his career, when he has tasted clinical work. Little would be lost by this if the Goodenough Committee's excellent provisions for the direction of each student into the sphere of work for which he proves to be best fitted are adopted. This would amount, in effect, to the selection by each student of his own career. It seems a pity that all university students cannot be given, by means, for example, of a first year during which they could taste, under the guidance of a tutor, every field of university work, a similar chance to select, under supervision, the work which offers them the best chances of combining in their lives a natural inspiration and interest and service of practical value to themselves and to the community. For the value to medicine of the non-medical worker is well recognized. The Goodenough Committee would, in fact, make special provision for the assistance of workers in other fields who may wish to switch over to the study and practice of medicine. There is no better background, it says, to a medical training than a university course in some other faculty, and it believes that the medical profession would benefit if more graduates in classics, history, languages or pure science entered it.

Although many readers of these two reports may prefer the proposals of the Goodenough Report for the selection of the medical student to those of the Committee of the Royal College of Physicians, all will agree with both committees that the masses of detail which now clutter up the medical curriculum should be resolutely pruned away. The emphasis, both Committees think, should be, during the early training in any event, on the teaching of principle and method. It will not be easy to select for removal the detail which the medical student will not require unless he should be able to show, at a later stage, that he is fitted to become, say, an anatomist, a surgeon, a pharmacologist or to enter some other field of work which requ res the acquisition of detailed knowledge. The Goodenough Committee rather emphasizes the difficulty of this task; but it does not shirk it. Such pruning could, its report suggests, reduce the duration of the medical training to four and a half years, and the report indicates the advantageous use of the time thus saved. This Committee further recommends that the curriculum should be constantly reviewed in the future by each medical school rather than by any body specifically appointed for this purpose. It will be necessary, however, not to exalt the teaching of principle and method so high that the value of factual knowledge is depreciated too much. The Goodenough Committee emphasizes the teaching of observation and deduction of the meaning of facts observed and also the proper statement in words of these facts and deductions. But, although the student who crams facts can pass many examinations, whether they be medical or not, the training of the memory must not be neglected. Much of the practising doctor's efficiency depends upon a memory for detail, because it is done under conditions and in places which preclude consultation with others or reference to books. On the other hand, many of the existing text-books in common use should, it is widely agreed, be either scrapped altogether or entirely rewritten. The Goodenough Committee's plans would markedly reduce the doctor's need for books and works of reference: in place of them it would substitute constant living and personal contacts with specialists and others whose job it would be to keep the student and the practising doctor up to date and in touch with the latest methods and knowledge. There would be, for example, abundant and wisely planned postgraduate courses for practitioners and for any others who required them. The reorganization of the medical teaching centres and their better distribution about Great Britain would largely remove the geographical difficulties of any individual doctor who wished to keep his knowledge and practice up to date.

The training given to the student should provide him with an abiding eagerness to excel in current practice and to forge new tools for the service of his fellows. The Committee of the Royal College of Physicians emphasizes the convergence in medical education of the vocational education of the medical school and hospital and the academic training of the university. Sir Thomas Lewis (*Lancet*, 619; May 13, 1944; and 649, May 20, 1944) has discussed the same theme in some detail. The Goodenough Committee's proposal that every medical school should be an integral part of a university would give the medical student both these kinds of training. Clearly he must have both, even at the cost of the proposed disappearance of the Scottish extra-mural medical schools which have given much good training in the past.

The early clinical training should, the Committee of the Royal College of Physicians believes, be an organized system of teaching correlated with the pre-clinical studies and with pathology, and it proposes an undergraduate clinical course, lasting three years, during which the teaching would be directed to principles and methods and the development of judgment rather than to the acquisition of factual knowledge. The Goodenough Committee formulates in detail a similar scheme, which is coupled with a scheme of pre-clinical teaching. The report urges the immediate initiation of this scheme. The whole scheme could not be adopted at once, because it

involves far-reaching changes, some of which require some years for their completion. They are outlined on p. 322 of this issue. Those which concern the appointment of more whole-time clinical teachers and the betterment of their salaries and conditions of work need not be long delayed and are urgently required. It should not be very difficult, especially in these times of rapid large-scale reorganization, to establish quickly one or more of the medical teaching centres described by the Goodenough Committee; or to put into operation this Committee's plan for a Postgraduate Teaching Centre in Hammersmith; or to establish the experimental undergraduate medical school recommended for the University of Oxford. If these were started any faults in the schemes laid down for them would be the more quickly detected and remedied, and also more readily integrated with the national health service, which will itself require amendment as experience of its practice grows. Universal co-education of men and women in medicine, which the Goodenough Committee places in the forefront of its programme, should certainly be introduced immediately. It has, this Committee tells us, been the normal and successful practice for many years in all the medical schools outside London. It is time to end for good this injustice to our women. It would be of little use, however, to introduce this urgent reform unless steps were also taken to implement the Goodenough Report's further recommendations that all hospital appointments for qualified practitioners should be filled by open competition, and that the sex of the applicant should not be a bar to these appointments.

The mention of the qualified practitioner brings us to the important recommendations made by both the reports under consideration with regard to medical qualification. The Committee of the Royal College of Physicians would institute a final medical examination consisting of two parts. The first part would examine the candidate at the end of the three years clinical course which this Committee recommends, and this would be designed to test the candidate's knowledge of principles and methods rather than his knowledge of facts. On its results the candidate would receive his medical degree; but this would license him to practise medicine only in a hospital under supervision. He would still have to show that he is fitted to practise independently. To demonstrate this he would have to spend a compulsory year during which he would hold paid resident hospital appointments in general surgery, general medicine, obstetrics and gynæcology, pediatrics and child health and in special studies. At the end of this year of hospital work the second part of the final examination would be taken. If the results of this showed that the candidate had sufficient practical and vocational ability, he would get his licence to practise independently. His further career would presumably be bound up with the national health scheme.

The Goodenough Report proposes a scheme conceived on the same general lines, but with only one examination; and many will think that it is the better scheme of the two. There has been, this report says, enthusiastic support for its recommendation that every medical student, after he has qualified but *before* he is admitted to the Medical Register and allowed to practi e independently, shall be required to serve as a junior 'house' officer for a year at one or more approved hospitals. Before this War about half the students admitted to the Register did this, and during the War, regulations and conditions have raised this figure to more than 90 per cent. These 'house' appointments should be confined, the Goodenough Committee thinks, to departments of general medicine and surgery and each appointment should last at least six months. While they last the student should be enabled to obtain experience in special departments, but 'house' appointments in these special departments and in departments of obstetrics and gynæcology should be held *after* he has been admitted to the Medical Register. The Goodenough Committee does not propose a second examination at the end of this compulsory period of hospital appointments. It would be sufficient if the student submitted, when he applied for admission to the Medical Register, certificates to the effect that he had held the required appointments to the satisfaction of the authorities concerned.

The uninstructed layman, who may be concerned very closely by these proposals, will no doubt heartily welcome them. They should, if they are combined with the Goodenough Committee's other recommendations, ensure for the public, in both health and sickness, the care of doctors who are doing their job because they like that kind of work and because they wish to serve their fellow men and women; and the work would be done by doctors of both sexes who would be as up to date as any planning can help to make them. If the public should get this kind of service—and it is to be hoped that the doctors themselves will be allowed to plan it, if only for the reason that they began to feel their way towards it long before any Government realized the necessity for any organized system of national health—the public itself has an obligation on its side. It must help the doctors. It must help to keep them as free as any other citizen to organize and do what they consider to be in the best interests of their patients. It must trust them when they say that their main purpose is to serve, as the best of them have served since the days of Hippocrates, their fellow men and women and to keep them in health, rather than to wait until they have to be treated for lack of health. We must all help also by allowing ourselves to be used, either as models of health or for the instruction of medical students in the signs and symptoms of disease. We must realize that we are members of a society inseparable from modern medicine and must therefore think as well as we can about the aspirations and difficulties of our doctors. We must think, too, of the betterment of the lot of women and children, which the recommendations of the two reports under consideration would inevitably bring about. These two reports, in fact, express, in a particular field, a major trend of modern thought which is exerting its practical effects all over the world.

# BOOKS: THE WAREHOUSE OF KNOWLEDGE

THE technical agencies in education and in the dissemination of knowledge are growing in kind and variety. In our basic seminaries—the schools—we have the teacher in the class and lecture rooms, the experimental laboratory, the workshop and garden, the cinema, the radio, and so forth. These are immediatly effective; but very seldom may the pupil refer back to them when and where he will.

In this respect the text-book differs from all these. Although the film, for example, can describe and illustrate, especially scientific phenomena, in such a way that no text-book could emulate, nothing but the book can claim the quality of permanence or give the enthusiastic pupil that pride of possession which is an essential need to the immediate aim of acquisition of knowledge and the ultimate aim of a good education. The pupil can refer back time and again to his books, he can read and re-read until he has digested all those books have to offer.

Furthermore, books and journals are practically the only means whereby an individual person is able to keep a record of the progress of knowledge. *Nature* itself, for example, is not only a forum for scientific discussion and a newspaper for men of science, but it also aims at building up a printed and therefore a permanent record of scientific progress and discovery, so that an issue of *Nature* of thirty years ago is in certain respects as valuable as this week's issue. This cannot be said of any other of the above-mentioned agents of education, in so far as any one individual person is concerned, since so few can hope to make a library of films.

Books and journals, therefore, must for a very long time continue to hold a unique position both in general education and technical training.

Unfortunately, unless help is quickly forthcoming, we shall soon find that the supply of books for all purposes, including general education, scientific advancement and research, medicine and so on, will be totally inadequate to meet even essential requirements.

A brief review of the present position carries this conviction.

The last year of peace was bad. We were living in suspense, and even education authorities were making do with books in hand rather than make their normal annual purchases. Publishers themselves restricted their activities because of the threat of war.

Thus, book production for 1938–39 was small, but the paper now allocated to publishers for books amounts to 40 per cent of their 1938–39 consumption —and a recent ruling of the Paper Control has made it impossible for publishers even to obtain their full quota.

Certain agreed restrictions such as thin paper, small page margins and small type have enabled such books as the ordinary novel to be produced on very much less paper per book, but other types, such as school books, were already produced on a strictly economical basis. Accordingly, the numbers of school and university texts, etc., that can be produced has probably been cut by something like 50 per cent throughout the period of the War.

In 1939 publishers carried good stocks of books and paper; but this reserve of paper has now been used, and the stock of books is rapidly decreasing.

Figures collected by the Publishers' Association from representative publishers show the following result:

| | Books |
|---|---|
| Stocks at end of 1942 .. .. | 33,136,254 |
| Printed during 1943 .. .. | 12,184,277 |
| | 45,320,531 |
| Sales during 1943 .. .. .. | 18,146,471 |
| Stock at end of 1943 .. .. | 27,174,060 |

With pre-war stocks of paper gone, the production for 1944 can reasonably be put at 10,000,000 books only. The sales for the year, though really governed by supplies, could not be put at less than 25 per cent up on 1943. This would give us the following position:

| | Books |
|---|---|
| Stock at end of 1943 .. .. | 27,174,060 |
| Estimated printed during 1944, say | 10,000,000 |
| | 37,174,060 |
| Estimated sales during 1944, say | 22,674,060 |
| Estimated stock at end of 1944, say | 14,500,000 |

Thus one more year will put the publishing of books, etc., on a real hand-to-mouth basis.

It must also be remembered that much of the stock shown in the above figures are still pre-war books in slow but constant demand—many of them are important books of their type, but they are not books that are in urgent and immediate demand. Accordingly, it is quite likely that some 10,000,000 of the stocks shown above should be deleted altogether from consideration of books available for immediate urgent necessity.

But the consumption tends to increase not merely rapidly but alarmingly. Schools that have made do for several years now wish to return to efficiency again. An enormous scheme is on foot for Army post-war education. And so it goes on. For home and export, books of all sorts are vociferously demanded.

What is the publisher to do? The demand is for all types of books—one type cannot be sacrificed to help another. Orders pour in.

The publisher is practically driven to printing small editions. This is a most uneconomic proceeding and entails increased prices to the public. An even worse effect is the additional work per book thrown on to printers and binders. Making ready, as it is called, is a very lengthy process and these short runs materially reduce both binders' and printers' output.

So we arrive at the state when even an increase of paper will not immediately ease the situation. It will take time to get back to longer runs, and it is vitally urgent that this return to economic methods of production be initiated forthwith.

Incidentally, publishers may be almost entirely

absolved of pressing for financial gain. Excess Profits Tax sees to that, and larger sales will only swell the Government's receipts—not the publisher's.

Printers and binders have, of course, been denuded of labour. Notwithstanding early official statements that books were necessary to the prosecution of the War, the book trade has been largely unprotected, and surely the time has now come to give the trade a chance to turn out the millions of books that are admittedly essentially required.

As mentioned above, demands are being received for books for Army education. Extra paper is promised for these, but printers and binders are not able to deal with additional work. As pointed out, a general increase in paper supplies would tend to ease the situation, but it is not possible to impose further demands on printers and binders whilst they are handling the present multitude of short runs.

However, the offer proves additional paper is available, as indeed do long-established cases of books produced of a popular technical nature for which paper has been made available by one or other of the Services. We do not know who has the authority to say which books are sufficiently valuable to the Services to merit Government paper, but we question his decision in many cases.

However, the Government has plenty of paper at its disposal, as indeed H.M. Stationery Office must now rank high as regards the quantity of its publications. Is this continuous stream of Government-backed but apparently unofficial pamphlets and booklets of greater value than the type of books which have been in demand for many years? Who has decided that this is the best use for paper in war-time?

The current consumption figures for paper as follows are of considerable interest:

| | Tons |
|---|---|
| Newspapers .. .. .. .. | 250,000 |
| H.M. Stationery Office .. .. | 100,000 |
| Periodicals .. .. .. (nearly) | 50,000 |
| War Office (included in H.M.S.O. quota) .. .. .. .. | 25,000 |
| Books (including the extra 2½%) .. | 22,000 |
| American Book Publishers' quota for 1943 was .. .. .. | 128,000 |

Presumably much of the War Department paper went on training booklets and the like. Surely training has now decreased to some extent, so that the publishers could have some or all of the now redundant paper. What about the Civil Defence Services? Surely these are organized now and could reduce their requirements for paper. And so with other Government Departments. At the same time, this reduction of H.M. Stationery Office paper consumption would reduce their compulsory orders to printers and binders. This would further help to square out the vicious circle now fettering the book trade.

For four years, educationists and men of science have valiantly shouldered the heavy burdens imposed by the short supply of essential literature in the form of text-books and technical journals. But surely science can claim war-time priority; furthermore, war or no war, progress in education must not be allowed to stop altogether, though it must, of course, *pro tem.* reduce its pace.

At present, of the 420,000 tons of paper in the country available for printing, only little more than 5 per cent is allowed for books—and this comprises books of all kinds, including those which with no stretch of the imagination can claim to have literary or educational merit. This position can and should be adjusted if educationists and men of science are to be encouraged to give of their best—and their roles at the present time, and even in the more difficult years of peace-making and reconstruction to follow, are of the highest importance. Readjustment can be made fairly simply by modifying the percentage of quotas.

# INDUSTRIAL TOXICOLOGY

**Industrial Toxicology**

Being the Croonian Lectures for 1942 of the Royal College of Physicians of London. By Dr. Donald Hunter. Pp. 80. (Oxford: Clarendon Press; London: Oxford University Press, 1944.) 10*s*. net.

ANY review of the present field of industrial toxicology necessarily suffers from the fact that it is more or less an 'interim' report, issued during a period when comparatively little has been added to the pre-war knowledge of existing toxic substances, and before the expected development of many new agents which may or may not prove injurious to workers exposed to them.

It is well that existing knowledge should be brought up to date, both from the biological as well as the purely chemical and physical aspect.

The latter is specially emphasized in Dr. Donald Hunter's review of a large number of toxic substances encountered in industry. Immunity from danger in handling many substances essential to industry both in war and peace depends to a large extent on accurate recognition of the chemical and physical properties of those already known to be toxic. Such knowledge can be usefully applied in forecasting the probable potential toxicity of new substances the harmful effects of which have not yet been emphasized by the results of bitter practical experience.

In Dr. Hunter's review, the relationship of chemical constitution and physical properties to biological activity is shown by many examples in the various groups of metals, aromatic compounds and chlorinated hydrocarbons. A typical difference in effect of the same element in different chemical combinations is the contrast between the manifestations of poisoning by inorganic lead, where true lead encephalopathy is now rarely seen, and the cerebral disturbance, sometimes terminating in violent mania, which is the outstanding phenomenon in poisoning by the organic compound, tetra-ethyl lead, and is unaccompanied by the classical symptoms of lead colic, palsy or punctate basophilia. The picture of severe chronic benzene poisoning, with the most frequent effect of aplasia of the bone-marrow, is also quite distinct from the specific capacity of the nitro- and amino-derivatives of benzene to convert hæmoglobin into methæmoglobin, and the special tendency of the amino-derivatives to attack the bladder, causing papillomata which may become malignant.

The large group of chlorinated hydrocarbons used in the rapidly growing cellulose lacquer and plastics industry show very clearly this variation in toxic effect according to chemical constitution. Halogenation appears to be closely related to liver damage, and increase in the chlorine molecule, though compensated to some extent by decrease in volatility, generally increases the toxic effect. Thus tetrachlorethane, no longer used as an aeroplane dope on account of its high toxicity, is about four times as toxic as carbon tetrachloride, while trichlorethylene is much less likely to attack the liver than either.

Recent investigations on the biological effects of toxic substances are described less fully. Only a very brief reference is made to an investigation on the mode of action of carbon tetrachloride when exposure is relatively mild and of long duration, as opposed to the better-known acute intoxication arising in connexion with its use as a fire extinguisher. Much light was thrown by this investigation on the true origin of the gastro-intestinal symptoms frequently observed in workers using tetrachloride as an industrial solvent.

A slightly more detailed account is given of an examination of the effects of trinitrotoluene, the experimental subjects being a number of students who volunteered to fill shells during their vacation. Very valuable information was thus gained as to the reaction of living tissue to T.N.T. without the accompaniment of severe or irreparable injury.

Of the newest group of industrial agents, the glycols, comparatively few have been fully investigated, but some, including ethylene chlorhydrin and diethylene dioxide (dioxan), have already given proof of their potency for causing damage. The cases of fatal dioxan poisoning which occurred in 1934 should act as a special warning against the assumption that substances which have never actually proved toxic can be regarded as harmless. Dioxan had not only been shown to be comparatively innocuous to animals, but the five men who died from hæmorrhagic nephritis had been exposed to it for nearly sixteen months without apparent ill-effect. It was only when exposure to the vapour was intensified by the speeding up of the machine and by the necessity for the men to put their heads into the vat containing dioxan that severe injury to the kidneys occurred.

The new aliphatic chemical industry, which has made great strides since 1925, may be expected to expand still further in the post-war years, and many substances of the group to which dioxan belongs may then reveal their true biological effects. At present their chemical and physical properties are better known than their potential toxic action, and it is to be hoped that this knowledge will be applied on the basis described in this review.

ETHEL BROWNING.

## A SURVEY OF STATISTICS

Statistics

By L. H. C. Tippett. (Home University Library of Modern Knowledge, No. 156.) Pp. v+184. (London, New York and Toronto: Oxford University Press, 1943.) 3s. net.

FEW sciences are more difficult to present in a concise and readable manner than statistics, which is regarded as a symbol of all that is dull and devoid of human interest. "What you've got," says Idaho Green in one of O. Henry's stories, "is statistics, the lowest grade of information that exists." To give the general reader an idea of the fascination of astronomy, biology and even mathematics is relatively easy; but this is the first attempt I have seen to perform that very useful function for statistics.

Mr. Tippett is to be congratulated on having made a success of his undertaking; and indeed, it is hard to think of anyone better qualified to attempt it. His familiarity with both the theoretical and practical sides of his subject, coupled with his interest and experience in the teaching of statistics, have contributed to an excellent Pisgah-view of a complex, dry and extensive domain. He is never at a loss for a practical illustration in point, but does not lose the thread of the main argument as is so easily done in a discussion of statistical examples. Within the limitations imposed by its length—about 50,000 words with a few tables and no algebraic symbols—he appears to me to have done just what is wanted of volumes in the Home University Library, to have given a general review of his subject for those who want to know what it is about and sufficient enticement to those who are likely to want to extend their knowledge further.

Mr. Tippett begins with four chapters on raw statistical material and its arrangement, presentation and summarization. The points he makes about pitfalls in the interpretation of numerical data, elementary as they seem, are so important to the average citizen that one wonders whether some part of this branch of the subject should not be taught in schools. I do not quite share his view about the readiness with which unpublished official information is put at the disposal of the private research worker. There seems to be a school of thought which holds that any material collected at the public expense by public servants for the public benefit should on no account be made public. But perhaps this feeling is coloured by war-time experience. It is to be hoped that after the War the State will realize that as much as possible of the information it collects should be published, or at least put at the disposal of 'unofficial' research workers.

The next group of chapters deals with sampling, probability and statistical laws. A further chapter on statistical reasoning is exceptionally good, and it is a real relief to see someone having a tilt at the prevailing methods of presenting numerical information about the progress of the War. One gets very tired of statements that our production of something or other is ten times what it was a year ago (which means that a year ago it was only one tenth of what it is now) or that the total tonnage of bombs dropped on Germany in some selected period is four times the weight dropped on England in some other period. Considerations of secrecy are admittedly paramount; but all the same censorship covers a multitude of statistical sins.

The concluding chapters deal with statistics in affairs and statistics and the other sciences. Mr. Tippett has only the space to deal with these topics in broad outline, but he contrives to give a very fair impression of the enormously wide interests of the statistician at the present day.

One criticism may be advanced. In the list of books for further reading at the end Mr. Tippett, with misplaced modesty, omits a reference to his own book on "The Methods of Statistics", a useful work which has done a good deal to spread the newer methods among scientific workers.

M. G. KENDALL.

# MEDICAL SCHOOLS IN GREAT BRITAIN

## THE GOODENOUGH REPORT

ON pp. 315–318 some of the main recommendations of the Report of the Inter-Departmental Committee on Medical Schools* are discussed. The length of the report and the detailed survey which it presents of existing medical organizations and the radical reforms which it recommends make it impossible to do more at present than to give here a brief summary of its main contents.

While the unity of medicine and the individual freedom enjoyed by medical schools in academic matters must be preserved, medical education must in the future develop the mind and character of the medical student in such a way that he can acquire a liberal university education, a scientific foundation for his work, an adequate knowledge of disease, a proper outlook on the promotion of mental and bodily health, a sympathetic understanding of people and their environment and sound judgment and ability to observe accurately, reason logically and assess the value of new knowledge. The emphasis in training should be on principles and methods rather than on the learning of facts, and there should be a bias towards the needs of the future practitioner. The report bears in mind the Government's plans for the future health of the nation.

The unit of organization for the future national system of undergraduate medical training should be a medical teaching centre, consisting of a university medical school and a group of teaching hospitals, comprising parent and associated hospitals situated as near as possible to the medical school, together with those clinics of the health service of the district which can be used for teaching. All these would function as a unit, but each constituent body in each teaching centre would retain full authority in its own field of responsibility.

Reviewing the existing medical schools in relation to this unit of organization, the report lays down the principle that every medical school should be an integral part of a university. Of the thirty existing medical schools in Great Britain all but four are university medical schools. The report proposes that the three extra-mural medical schools in Scotland, namely, the School of Medicine of the Royal Colleges of Medicine and Surgery, Edinburgh, the Anderson College of Medicine, Glasgow, and St. Mungo's College, Glasgow, should cease to train students. The report gives a valuable history of the development of these Colleges and also of their relationship with medical education, and pays a tribute to the excellent work which they have done in the past; but it is considered that they are not adequate to the modern needs of medicine. The work of these Colleges and the possibility that the proposals of this report may eventually result in the disappearance also of the 'Conjoint' diploma granted by the Royal Colleges of Physicians and Surgeons of London are discussed by the *British Medical Journal* (154; July 29, 1944). The Goodenough report also proposes that the West London Hospital Medical School should cease to train students within the next four or five years. The Committee recognizes its excellent work, but its proposed disappearance is related to the report's other recommendations relating to the University of London. Medical education in London, indeed, constitutes a special problem the various aspects of which the report considers at considerable length.

No changes are recommended in the administration of the university medical schools in Scotland, Wales and the English provinces, except that it is recommended that the governing bodies of the hospitals should be represented in the government of the medical schools wherever this is not at present the practice. The Committee also thinks that, although participation by the dean of a medical school in academic and teaching work is valuable, the dean of the future will probably not be able to continue this kind of work and that he will have to be a whole-time salaried official. But in London administrative changes will be necessary. It is recommended that all London University undergraduate medical schools should become separate legal entities, that the University of London and its medical schools should be more closely associated and that the University should be represented on the governing bodies of its medical schools. Both the University and its medical schools will need to make contributions to this development. Further, the geographical distribution of the London medical schools was, the Committee thinks, unsatisfactory even before the War. This subject is discussed in relation to the tendency of the population of London to move from the inner to the outer areas of London, to the consequent likelihood that hospitals in the centre of London will not get so many patients and to the need to provide individual medical schools with increased teaching facilities.

The complexity of this problem can only be realized by reading the discussion of it in the report. The Committee's conclusion is that, as soon as possible, Charing Cross Hospital should move to a site in Middlesex and St. George's Hospital to a site, say, in South London where hospital accommodation is urgently needed; and that, when this is done, the medical school of each of these hospitals should expand and provide both pre-clinical and clinical training. These moves would leave a distribution of medical schools and their parent hospitals which would be reasonably satisfactory, except in the area in which University College Hospital, Middlesex Hospital and the Royal Free Hospital are grouped, together with nineteen other hospitals, within a radius of one mile. Six of these hospitals are, moreover, special hospitals in which postgraduate education should be developed. It seems extremely doubtful, the report says, that this area will, under a co-ordinated hospital system, be able, in a few years' time, to provide adequate clinical teaching for three medical schools of the size that is contemplated by the report. It is therefore suggested that the London School of Medicine for Women and the Royal Free Hospital should consider a removal. A site in the northern suburbs of London, such as Highbury, is suggested.

The Committee's views on the selection of students are also progressive and in line with modern trends of educational thought. They are discussed elsewhere in this issue. Financial assistance to students is considered in detail. Scottish faculties of medicine draw students from all classes of the community, but England and Wales do not draw them from so wide a field, largely because parents do not understand how much assistance can be obtained and because

* Report of the Inter-Departmental Committee on Medical Schools. (Chairman: Sir William Goodenough.) Pp. 306. (London: H.M. Stationery Office, 1944.) 4s. 6d.

secondary school students are not sufficiently encouraged to take up medicine. The report states that grants to medical students should cover the whole period of training and should cover the cost of maintenance, which is the greater part of the cost. The machinery for awarding public funds for this purpose should be simplified and private organizations and charitable trusts should keep in touch with those who administer public funds. Medical schools should have more adequate funds for the assistance of students.

The wide range of interests in medicine and the fact that lack of money need not debar anyone from taking it up should be brought home to all parents. It is the primary obligation of British medical schools to train students born in Britain, but suitably qualified students from abroad, and especially those from the Commonwealth and the Empire, should be welcomed. Every university should have a students' health service with a medical man in attendance. Medical examination of students at the beginning of their training and at intervals thereafter, the provision by the universities and medical schools of nourishing meals at reasonable prices and of facilities for exercise, games and recreation are recommended, and the value, especially for medical students, of residential college life is stressed, because the relations of people to one another will play such a large part in their future work. Many students will have to live in lodgings until accommodation of this kind can be provided, so that supervision of lodgings and the health of students living in them should be a responsibility of those who are training them.

Dealing with the larger question of the number and distribution of British medical schools, the report points out that it is expected that the number of civilian practitioners will continue to grow for some years to come. To provide for this it is better to expand the existing medical schools rather than to create any new ones. Plans for these expansions are given.

The Universities of Oxford and Cambridge are considered separately. At Oxford the medical school was, before 1937, mainly a pre-clinical one, but during the War, a complete undergraduate medical training has been given. The University does not wish to continue this in its present form, but wishes to retain it in a specially modified form, designed to develop teachers, investigators and consultants, rather than general practitioners. There would be only a small number of students and these would be carefully selected and would be instructed individually, with special emphasis on the scientific approach to medicine. Only about fifty students would be admitted to the pre-clinical course and about 20–25 a year to the clinical course. Students who had taken their pre-clinical courses elsewhere would be admitted and exchanges with other universities in Britain and overseas would be encouraged. The Committee thinks that there is a fair chance of the development in Oxford of the kind of medical teaching centre which its report proposes, and it thinks that Oxford should have the necessary financial aid to continue a small clinical school after the War. It would, the report says, be opportune to give, after the War, an existing undergraduate medical school this kind of opportunity to develop on new lines; it might open up a new era in medical thought and practice. "One radical experiment in the training of medical students promises a most effective means of fostering improvements," which may well influence the character of medical education in the next generation. At Cambridge, the recent discussions there of a scheme to establish a clinical school are reviewed, and the report concludes that such a school should not be established until the local hospital services are raised to a very much higher standard. Active postgraduate clinical departments should first be created. These are most desirable and can be developed piecemeal. A beginning might be made with departments of psychiatry, experimental medicine and radio-therapy.

Dealing with hospitals the report points out that in the past the needs of medical education have not been emphasized sufficiently and teachers of medicine have not had sufficient voice in the management of teaching hospitals. It is suggested that parent teaching hospitals should not become university hospitals, but that the reforms desired should be obtained by giving the governing body of the medical schools sufficient representation on the governing bodies of the parent, and also, though this is not so important, of the associated hospitals. The governing body of the hospitals should be personal to the hospital. The full medical members of the staff should have complete individual responsibility for clinical management of their patients and a medical committee should advise the governing body on medical matters. If a medical superintendent exists, he should not have executive powers over clinical management of patients unless these are delegated to him on the advice of the medical staff. The report considers it important that common advisory machinery should be used by all parts of the medical teaching centre for the selection of the medical staff other than the junior grades, and that grants from public funds should be received through university channels. For details of the clinical instruction to be given in these hospitals or groups of hospitals and of the relations of their staffs to the universities and medical schools the report itself must be consulted. The report insists that every means should be used to bring every hospital into relation with a medical teaching centre and that the spirit of education should permeate the whole service. The medical teaching centre would thus become the centre of a wide zone of influence. If central health service councils are established as a result of the introduction of the national health service scheme, the universities should be given adequate representation on them and should have representatives on the local health services councils in their areas. All these university representatives should have the same status as representatives of other interests.

A section on the staff of pre-clinical departments of medical schools does not propose any fundamental changes, except that it is hoped that selection and appointment of candidates for regius chairs will be transferred by the Crown to the universities concerned. Higher salaries are proposed for teachers of pre-clinical subjects and there should be more senior posts in this category and time to enable junior grades to do research and to read more. Fundamental changes are, however, proposed in the staffing of clinical departments other than those of pathology. At present only a small proportion of the senior clinical staff hold whole-time appointments; the chief occupation of many, if not of most, is private practice and usually they are not paid salaries. Most are selected without reference to the medical schools, and usually there is nobody who is responsible for the organization and direction of clinical teaching

and research. To remedy these faults, the report proposes detailed schemes for the creation of more whole-time and part-time appointments and for the selection of those who will hold them. These would vastly improve both clinical education and the present very unsatisfactory position of the clinical teacher. To this the report adds a long and detailed consideration of the whole curriculum and proposes drastic changes in it.

Some of its proposals for the selection of medical students are discussed on pp. 311–314. Premedical studies are not, the report considers, satisfactory. Training in the physical and biological sciences is, the Committee thinks, best begun at school, and it should be continued at the medical school in close association with training in anatomy and physiology. In the secondary schools this would involve changes in the teaching of science and the provision of suitable laboratories and other accommodation. More teachers would be required by the schools, and improvements in the quality of the teaching, especially in the teaching of biology, are needed. Such changes require time. Considering interim arrangements, the Committee says that it would accept the School Leaving Examination suggested by the Norwood Committee as an exemption from the First Medical Examination, provided that excessive specialization should not be possible, that general science should be taught over most of the school career and not merely during the last two years, that the syllabus should not be a special one for medical students and that general science should be treated non-vocationally with emphasis on principles and methods rather than on the acquisition of facts. Appropriate modifications are suggested for Scotland. Until this plan can be put into practice, medical students should attend a special pre-medical course in general science for one year at the university and should pass an examination in it of approximately the same standard as that of the senior school leaving examination. To emphasize the Committee's desire that the syllabus for this course should, like that proposed for schools, not have a vocational bias, this first medical examination should be called, not the First Medical, but the Pre-medical Examination. The report emphasizes that entry to this examination should be restricted to those whose general education is high enough to allow their entry to the medical course and to those who have prepared for it at a university or university college. The practice of preparing for it during their last two years at school should be discontinued as soon as possible.

The report then discusses what it calls the pre-clinical subjects, namely, anatomy, physiology (including biophysics and biochemistry), elementary normal psychology and pharmacology. The student's training in these largely determines, the Committee thinks, his attitude and methods in the clinical course to follow. Teaching of these pre-clinical subjects should be organized in the closest association with other university departments and with the parent teaching hospital. To bridge the gap between the pre-clinical and clinical courses an overlap of personnel would help, and there should be freer access to patients for the teaching of anatomy and physiology. One medical school is considering teaching anatomy and physiology as two aspects of human biology, and this idea appeals to the Committee, although most medical schools are unlikely to adopt it at present. A committee should organize the pre-clinical studies. An amendment of the Anatomy Acts or new legislation might help to remedy the present shortage of material for the teaching of anatomy. Some instruction in the recording of facts and in the deduction of their meaning should be given. There is urgent need in every medical school for the drastic elimination from the curricula and from the examinations of masses of detailed information. A change of outlook by the teachers should also direct the student's attention to the importance of health and the prevention of disease. More studentships, scholarships and maintenance grants are required to encourage postgraduate students to act as members of research teams.

Certain special arrangements in London occupy a section of the report which recommends that pre-clinical and clinical departments should be near to one another and that, with certain exceptions, every medical school in London should provide for both these parts of the training. Elementary teaching in chemistry, physics and biology for students who have not had this at school should be concentrated at the colleges only, such as University College, King's College, Bedford College and Queen Mary College, which have science and other faculties.

The teaching of pathology receives special consideration. Normally there should be at a teaching centre four departments in this subject, namely, morbid anatomy, bacteriology, chemical pathology and clinical pathology, each with a whole-time professor or other senior officer and adequate staff. A director should be in charge of the whole, and he could be one of the departmental heads; he would have charge of pathological investigations in the parent and associated hospitals. A medical student does not need detailed knowledge of pathology or technical skill; his training in the principles of pathology should be spread over the whole clinical period. There should be day-to-day collaboration between clinicians and pathologists at the bedside, in the out-patients departments and in the laboratories.

In the clinical courses the report seeks, as it does throughout the whole training, to organize correlation between the various subjects taught. An introductory clinical course of not less than four months is proposed to effect a smooth transition from pre-clinical to clinical courses. This course should indicate the relation between the earlier studies of the human body in health and later studies of it in illness, should encourage students to carry to these later studies the scientific thought and criticism which they have learnt earlier and should teach them to observe and interpret the clinical signs of disease. Such a course will make heavy demands on the time of teachers and on clinical facilities. A medical student needs a unified knowledge of medicine and has to acquire it largely from specialists, and this creates problems associated with the growth of specialization. The report proposes that in the training of specialists a sound postgraduate experience should precede specialization. The teaching of students by means of clinical units would be continued, but the report proposes to link these with the academic heads of the five divisions into which it divides the whole training; and it recommends that there should be periodical informal meetings of all the teachers and also that the views of the students should be obtained. For the details of the very interesting discussion of this complex subject, which contains much historical material of great interest, the report itself must be consulted. Among valuable recommendations are the

emphasis on principle and method, the need to give proper attention to the problems with which general practitioners are faced, and to minor ailments and the early signs of disease and to rehabilitation. Some surgical procedures are better taught after graduation.

The report gives a valuable history and discussion of the functions of the General Medical Council. There is need, it considers, of some central source from which medical schools could obtain guidance, and the report proposes to extend the powers of the General Medical Council to enable it to appoint inspectors, who would not be members of the Council, to visit medical teaching centres and report upon the courses of study, staff, accommodation and other matters. Copies of the reports of these inspectors and the comments of the Council and of the institutions concerned should be sent to the University Grants Committee. There follows the recommendation that every medical school should provide a single organized course, and should make it compulsory that every medical student should complete this course before taking a clinical examination which might qualify him for admission to the medical register. This would prevent the practice of taking qualifying diplomas not granted by universities (such as the Conjoint diploma, the diploma of the Society of Apothecaries, etc.) before the university course is completed. Some students, having obtained such a diploma, do not at present take their university degree in medicine at all. In London especially there is constant and detrimental competition between the University and the English Conjoint Board and the Society of Apothecaries. Only 5 per cent of the male students admitted by the University of London to take the university degree actually do take it as their first medical qualification, while 86 per cent register by means of the Conjoint diploma and only 45 per cent eventually take their university degree. A further recommendation is that the University of London should remodel its examinations so that these should reflect the aims and spirit of the training and should include more features of the 'internal' kind of examination, which is defined as an examination regulated by the university which trains the student who takes it and conducted by the student's own teachers in collaboration with external examiners. The latter, together with the inspectors of the General Medical Council, should safeguard the public interest. This suggested reform of the examinations held by the University of London also applies to the Universities of Oxford and Cambridge. A system of internal departmental examinations might complement and relieve the burden of these final examinations and encourage students to pay proper attention to all parts of the training.

Postgraduate training and research are dealt with in Part II of the report. Assuming that suitable central machinery should determine specialist status and that the specialist should first obtain general hospital experience, the report recommends that the intending specialist should be regarded as a trainee while he holds hospital appointments and should have sufficient time for reading and research and should be adequately paid. He should complete at least six months experience in general medicine and surgery as well as his pre-registration hospital experience. Watch should be kept for potential teachers among these intending specialists. There should be travelling fellowships for them, and nothing should debar a general practitioner from training to be a specialist. The most useful contribution of existing postgraduate medical schools would be to provide clinical appointments for specialist trainees. In Great Britain there is a singular lack of facilities for training specialists in hospitals dealing with special branches of medicine. Institutes dealing with these special subjects should be established, on a national plan, as departments of medical schools and universities based on large special hospitals. The Goodenough Committee's views on the education and status of specialists may be compared with those of the committee appointed by the General Medical Council to consider the registration of specialists, the report of which is summarized in the *British Medical Journal* (188; August 5, 1944).

Corresponding arrangements should be made for the training of specialists in pathology and public health; but adequate training in tropical medicine and hygiene cannot be obtained in Great Britain. After obtaining his theoretical and laboratory training in this subject here the intending specialist should hold approved hospital appointments abroad. Regular postgraduate study is required by practitioners, but refresher courses are only a short-term expedient and practitioners should be brought into regular association with the work of hospitals and of specialists by such means as clinical assistantships and personal associations. Refresher courses will, however, be necessary for many years and they should be specially designed for the practitioner. If it be decided that they should be compulsory, adequate financial arrangements will be needed similar to those embodied in the National Health Insurance scheme. The universities should organize these refresher courses and should approve teachers who give them. Such schemes of postgraduate education should be organized by a committee appointed by the university with a supervisor who would integrate his work with that of the Dean of the faculty of medicine. The exceptional resources of London as a centre of postgraduate education are not being utilized properly. The British Postgraduate Medical School should be an integral part of a postgraduate hospital centre in the inner area of London. This would seem to be impossible at present, but a satisfactory organization for postgraduate medical education can be created round the British Postgraduate Medical School on the basis of the Hammersmith (L.C.C.) Hospital and the existing special hospitals. These should be reconstituted as a federal organization with institutes dealing with the principal special subjects, and a scheme for this is outlined. The University of London should, however, like other universities also, appoint a committee on postgraduate medical studies. The award of postgraduate medical diplomas is also unsatisfactory. There are too many of these and the standards on which they are awarded vary considerably. They should all be awarded by the Royal Medical Colleges, excepting those given in public health, clinical pathology, bacteriology and tropical medicine, which should be awarded only by the universities providing the courses of instruction in these subjects.

Innumerable problems await research, and men with the ability for and impulse to do research must be found; they must be given favourable conditions for their work and the tools that they need. Young research workers should mainly recruit themselves, but they should be guided and given reasonable security in their careers. Scientific workers in fields other than medicine are required. The report reviews the work and methods of the Medical Research

Council and makes important proposals with regard to the provision of staff, accommodation and access to patients required for medical research. Basic research grants from public funds and others from private and public sources are required, and the Medical Research Council would be assisted if the funds granted to it by Parliament were determined annually.

Part III of the report deals with future financial requirements and with machinery for the distribution of Exchequer grants. The report must be consulted for details of these; but it may be noted that the University Grants Committee is given the responsibility for the distribution of basic research grants and Exchequer grants for educational facilities. It is suggested that this Committee, should appoint an advisory panel of persons with current experience of medical education and teaching hospitals.

# PHOTOCHEMISTRY IN RETROSPECT

By DR. T. IREDALE
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PHOTOCHEMISTRY now appears to be a well-established science with a highly developed technique of its own and an adequate foundation of theory, based largely on indisputable facts established by the molecular spectroscopist. Recent text-books[1] leave the reader in no doubt as to the correct avenues of approach to this subject. Its devotees must be prepared to undertake the detailed study of absorption spectroscopy, reaction kinetics, the behaviour of free radicals, and the electronic transitions in solids, some of which are still largely unexplored fields. The more serious student, however, will be disappointed to find that the historical approach to photochemistry has been greatly neglected in these books, excellent as they are in other respects. In the historical treatment of a science interesting sidelights are often shed on scientific method, and the lessons we can learn from them are of peculiar value. For example, it would be instructive to reveal why certain lines of investigation were dropped, how some apparently slight but fundamental observations led to developments of the greatest magnitude, why a fundamental law universally acclaimed and applied appears now to be worth only passing consideration. Photochemistry in particular, which has reached the greater part of its present stature within the last twenty years, has some interesting things to reveal which come within these categories.

During the nineteenth and early twentieth centuries, since the time of Grotthus and Draper, photochemistry made little real progress. The chemical interaction of light and matter was always a baffling mystery. Impetus to experimental work in certain directions was not lacking, because the sister science of photography was always confronted by problems which could not be solved by empirical methods alone. It was not in its applications, however, that photochemistry made its greatest progress.

Some of the most renowned investigations of three or four decades ago were concerned with the thermodynamic implications of photochemical change. This was a rational development, because light sometimes interfered with the laws of thermal equilibrium in a way which necessitated new assumptions and new theoretical treatment. In working along these lines investigators were not so fortunate, for while the chemical equilibria might be explained in general terms of free energy change, the mechanistic consequences of the light absorption itself were not properly understood, and highly speculative theories were put forward to account for this aspect of the phenomenon. This was before the advent of the quantum theory, or rather, before its immediate application, especially to problems of atomic structure.

In 1912 Einstein announced his well-known Law of the Photochemical Equivalence, derived from thermodynamical considerations of radiation equilibria, and later on deduced the same law, based on the Bohr model of the atom. Stark's idea of electron loosening in molecules, put forward some years before, had something in common with Einstein's generalization, which might have been a continued impetus to research, were it not for the fact that it was the exception, rather than the rule, for the law to be obeyed by any of the photochemical changes investigated from time to time. So far, indeed, has this law fallen from grace, that in one of the books previously cited, no mention whatever is made of it. One would not expect such an important landmark in the history of the subject to be relegated so soon to the limbo of forgotten things. The pioneering work carried out by Warburg, Bodenstein, Weigert, Bowen and others to test the efficacy of this law, when seen in its proper perspective, will be found to hold a very necessary place in the development of the subject.

In 1925, J. Franck[2], in a short exposition, correctly interpreted the relation between banded and continuous absorption spectra of diatomic gases, and brought to the photochemist the realization of the excited molecule as distinct photochemically from the normal or excited atom. This may be said to be the beginning of modern photochemistry as we know it to-day. On the spectroscopic side, the volume of research which followed immediately after Franck's discovery forms one of the most amazing chapters in modern physical chemistry. This much the photochemist could learn from it, at least about the simpler molecules he was accustomed to handle: he could deduce from the absorption spectrum what the light quantum did to the molecule. The subsequent complexities of chemical change were not always easy to follow, and sometimes assumed proportions which baffled the ingenuity of the most expert investigator. Thus it was that the light interaction part of a photochemical change, hitherto so elusive, became its most intelligible feature, the kinetics of the following-on reactions presenting much greater difficulties. But as the kinetics are merely bound up with final states of equilibrium, we must expect the last phase of photochemistry to be the standardization, thermodynamically, of the photo-stationary state.

The photochemistry of more complex molecules, apart from polymerization phenomena, has become largely the chemistry of free radicals, although prior to Paneth's instructive experiments in 1929, few investigators would have cared to be dogmatic about the existence of these short-lived intermediaries. The later work of Norrish, Pearson and others demonstrated beyond doubt the important part played by free radicals in photo-changes, albeit the behaviour of these radicals in the condensed (liquid)

phase has raised some new and at present unsolved problems.

The applications of photochemistry in the industrial sphere have been few and far between; this is not surprising, when one remembers that many chemical changes accelerated by light can also be carried out thermally, which is often the more economical method. Photochemists with their highly specialized technique are notoriously wasteful of light, employing, as they frequently do, narrow beams of the filtered radiation, utilizing only a fraction of the optical equivalent of the electrical energy expended in producing the light source. The most economical arrangement requires the light source to be in the centre of the reacting materials, so that the stray radiation is reduced to a minimum, which sometimes involves great practical difficulties.

A more profitable utilization of light may come about as the result of further exploitation of so-called electron transfer phenomena. Redox potentials, which are dependent on the activities of ions of variable valency, can be changed appreciably by absorption, by the ions, of light of great intensity, which is responsible for the electron transfer. The construction on the industrial scale of photo-galvanic cells working on these principles will be a problem for the electrochemist. In countries where sunlight is most abundant, there will be possibilities for much applied research along these lines.

[1] "Photochemistry", by G. K. Rollefson and M. Burton. "The Photochemistry of Gases", by W. A. Noyes, jun., and P. A. Leighton. "Chemical Aspects of Light", by E. J. Bowen.

[2] *Trans. Faraday Soc.*, 21, 536 (1926).

## THE COSMIC TIME-SCALE

IN a series of recent mathematical papers, culminating in a general review of the subject in more physical terms[1], S. Chandrasekhar has laid the foundations of a statistical theory of stellar dynamics which treats the subject in a way fundamentally different from the ordinary analytical approach. Certain aspects of the theory concerning the dynamics of star clusters and the statistics of binary stars are discussed in detail by Chandrasekhar; they have interesting repercussions on current ideas concerning the time-scale of the universe, and are summarized below.

In this new statistical treatment, no attempt is made to follow in detail the history of any particular star in a gravitational assemblage: its motion is described in terms of a distribution function governing the probability of occurrence of a given velocity at a given time, the initial velocity being specified. The behaviour of each star is regarded as determined in part by the influence of the system as a whole and in part by the relatively rapid fluctuations produced in the local stellar distribution as the members of the system change their relative positions. Chandrasekhar shows[2] that, in an interval of time large compared with the average period of these fluctuations, their cumulative effect is to subject each star to a random acceleration and simultaneously to decelerate it in the direction of its motion by an amount proportional to the time interval. The effect of the near neighbours of a star is thus expressible in terms of a coefficient of diffusion and a coefficient of 'dynamical friction'. The latter term is chosen because the process operates only on stars in motion and it acts systematically as a brake on this motion. It can be shown that a dissipative force of this nature is necessary for the maintenance of a Maxwellian velocity distribution among the constituent stars.

The recognition of the part played by dynamical friction in the evolution of stellar clusters leads to important conclusions regarding the expectation of life of these systems. The technique of this new statistical dynamics can be used to calculate the probability that a star of given initial velocity will acquire (for the first time) another specified velocity at some later time. If for this second velocity we choose the velocity of escape from the cluster (twice the root-mean-square velocity of the stars) we have a means of estimating the rate at which a cluster disintegrates by impoverishment due to escape of its constituent stars. Chandrasekhar expresses[3] the probability $Q$ that a star will escape from a cluster during a time $t$ in the form

$$Q = 1 - e^{-t/t_0},$$

where $t_0$ is a function of the physical parameters (radius, central condensation, etc.) of the cluster. Taking $t_0$, in accordance with this expression, as a measure of the half-life of the cluster, and substituting the observed parameters for the Pleiades, he finds a half-life of $3 \times 10^9$ years. Now the Pleiades form a typical galactic cluster, one of many such which are presumably permanent or *quasi*-permanent features of the Milky Way system. In so far as we may identify the life-history of the Galaxy with that of its open clusters, then the half-life of the Galaxy is also of the order of $3 \times 10^9$ years. Moreover, if we adopt Chandrasekhar's definition[4] of the 'time-scale' of the Galaxy, namely, a natural unit of time during which the aspect of the Galaxy may be expected to change appreciably, then $3 \times 10^9$ years is this unit, whether the galactic clusters are permanent features of the system or products of some passing phase of cosmic evolution.

Further evidence regarding the time-scale of the universe comes from a study of the statistics of double stars. Until a few years ago it was believed that the observed frequency distribution of eccentricities among binaries showed that a condition of thermal equilibrium had been attained, and thus that the time-scale adopted for the Galaxy must be long enough ($\sim 10^{13}$ years) to allow establishment of equipartition among the parameters of a binary. It is now known[5], however, that the observed distribution, though a necessary, is not a sufficient condition for the existence of thermal equilibrium, and further, that other aspects of the data, particularly the distribution of energies or semi-major axes, are incompatible with equipartition. In itself this suggests that the time-scale cannot be so long as had previously been believed, and Chandrasekhar's new treatment[6] of the question confirms this. In this approach he examines the stability of a binary as it is affected by the differential effects produced on the components by the gravitational attraction of neighbouring stars. For any given separation between the two stars, there exists a distribution function governing the probability that forces differing by a specified amount will act simultaneously on the two components. In other words, a systematic differential acceleration governed by a definite probability law acts on the system so as to accelerate one star relative to the other. The rate of dissolution of a binary due

to this cause is calculated and shown to depend on the masses and separation of the components and on the local stellar density. In the neighbourhood of the sun, the time $\tau$ of disruption of a typical binary of semi-major axis $a$ astronomical units is shown to be

$$\tau = 2{\cdot}2 \times 10^{15}\, a^{-3/2} \text{ years,}$$

$\tau$ being the time needed to produce enough relative acceleration to make the kinetic energy of relative motion exceed the gravitational binding energy between the components. For separations in the range $10^3 - 10^4$ astronomical units, this formula gives times varying from $7 \times 10^{10}$ to $2 \times 10^9$ years. But observation shows that in this range statistical equilibrium has not yet been reached in the separations. That is to say, sufficient time has not yet elapsed for the fluctuating gravitational field even to modify appreciably the semi-major axes, much less to dissociate the systems. Here again, then, the time-scale indicated is of the order of a few thousand million years.

These investigations on the stability of star clusters and of binary stars reinforce the many other lines of evidence which point to a 'short' time-scale of $10^9$–$10^{10}$ years for the universe. The 'long' time-scale of $10^{12}$–$10^{13}$ years suggested, for example, by considerations of equipartition of translational energy among the stars, and by study of the evolution of moving clusters, finds less and less support among astronomers. Many of the arguments which seemed to demand it depend on mechanisms which, though they operate in one way now, may have operated quite differently in the early history of the universe. Gravitational interactions, for example, were possibly of a different order of magnitude then from what they are at present. The long time-scale is, indeed, appropriate if, as was thought likely some years ago, the energy-producing mechanism in stars is simple annihilation of matter; but the current theory identifying it with the synthesis of helium from hydrogen favours the short time-scale, and is the only one which has been made even remotely consistent with the facts at present known. Furthermore, direct measurements of the uranium/helium and uranium/lead ratios in pre-Cambrian rocks, and of the helium, uranium and thorium contents of iron meteorites[7], give ages ranging from 2 to $7 \times 10^9$ years. Again, if we accept the red-shift in the spectra of the extragalactic nebulæ as a velocity effect and extrapolate backwards using their present velocities, we find that they must have taken about $1{\cdot}8 \times 10^9$ years to reach their present positions.

This is no doubt a somewhat naïve approach to the subject, but in a very recent paper on the recession constant of the galaxies, Eddington concludes[8] that "the time-scale for the evolution of the universe is definitely less than $90 \times 10^9$ years, and I do not see much prospect of evading this limit". But all these lines of argument are not so conclusive that we can dismiss other methods of attack, and these recent researches of Chandrasekhar provide a valuable check on the currently accepted theory that the time-scale appropriate to the universe is the short one of $10^9$–$10^{10}$ years.

A. HUNTER.


1 *Ann. New York Acad. Sci.*, **45**, 131 (1943).
2 *Astrophys. J.*, **97**, 255 (1943).
3 *Astrophys. J.*, **98**, 54 (1943).
4 *Science*, **99**, 133 (1944).
5 *Nature*, **137**, 537 (1936).
6 *Astrophys. J.*, **99**, 54 (1944).
7 *Nature*, **149**, 235 (1942).
8 *Observatory*, **65**, 211 (1944).


# OBITUARIES

## Sir Henry Lyons, F.R.S.

SIR HENRY LYONS was born in 1864: he was educated at Wellington and Woolwich and passed into the Royal Engineers in 1884; in 1896 he was appointed director-general of the Geological Survey, Egypt, and four years later director of the Survey Department of that country; during the War of 1914–18 he was commandant of the Meteorological Section R.E., and during 1916–18 he administered the London Meteorological Office; from 1919 until 1933 he was at first secretary and then keeper of the Science Museum, South Kensington. What a strange series of occupations: the army, geology, surveying, meteorology and museum management; yet it contains the key to his great and undoubted success, for it will be noticed that from the age of thirty-two years he was in charge of important Government departments. Lyons was first and foremost an organizer and administrator; he loved administration for its own sake, especially the administration of scientific organizations, but he was always ready to undertake administration of any kind so long as it involved reorganization and development.

Going to Egypt in 1896 as director-general of the small Geological Survey, he soon saw the need for a much more extensive survey, as little was then known with accuracy of the topography of the vast valley of the Nile and of the regime of the great river which flows through it. The Survey of Egypt was created, and Lyons organized it and directed it for eleven fruitful years. The valley was surveyed and the flow of the river scientifically measured; at the same time archæological remains, especially those to be submerged by the enlarged Aswan Dam, were studied and recorded. In 1906 Lyons published his book "The Physiography of the River Nile and its Basin", which reviewed all that was then known of the geology, climate and hydrology of the whole basin of the Nile. It is the most important scientific work on the Nile which has been produced up to the present time; it contains matter of the utmost importance for science and for the economy and government of Egypt. This work with other smaller publications earned for Lyons his position as one of the outstanding geophysicists and geographers of the British Empire. In 1909 Lyons returned home and lectured for a time on geography at Glasgow.

When war broke out in 1914, our army authorities had never even considered what meteorological help the army would need. The use of the aeroplane and the greater precision required by the artillery soon made it necessary to have a meteorological service at the front, and in 1916 it was decided to form a Meteorological Section of the Royal Engineers; and Lyons was put in charge as commandant. With Lyons' organizing ability in London and Ernest Gold's technical knowledge and immense drive in France, the new service was soon in full operation. By the end of the War the Meteorological Section R.E. had achieved a success which is not sufficiently known and appreciated. The experience and organization of the service built up in 1916 have been the foundations of the vastly increased meteorological service for the forces which is playing such a responsible part in the present War.

In 1916 Sir Napier Shaw, director of the Meteorological Office, found himself completely occupied with the preparation of meteorological information

required for the prosecution of the War; to relieve him Lyons took over the administration of the Office. He carried out the work with his usual ability for more than two years; but his period of service was too short and the conditions too abnormal for him to have left any permanent impression on the organization of the Office.

In 1920, after having served for a year as secretary, Lyons was appointed keeper of the Science Museum. Only those who knew the Science Museum in 1920 and were familiar with it just before the present War broke out can appreciate the great work carried out by Sir Henry Lyons at the Museum. In 1920 the Science Museum was a good museum, one of the best—if not the very best—of its kind in the world; but it was only a museum, governed by all the traditions of museum keeping and museum visiting. Lyons had no use for traditions; in fact the chief element in his success as an administrator was his willingness to break with traditions. Lyons wanted the museum to educate, and he knew that to do that the visitors must be interested. So every exhibit which could work was made to work, and if it could not work a working model was constructed in many cases. Life-size reproductions of famous workshops and laboratories were erected and demonstrations of modern scientific developments, such as radio and television, were arranged. Perhaps one of his most successful innovations was the series of demonstrations, accompanied by lectures and discussions, of new technical processes, such as the properties and manufacture of plastics. Instead of considering children a nuisance in a museum, he welcomed them and arranged one of the galleries especially for them. These are but a few examples of the changes made, but they illustrate the breath of life which Lyons breathed into the Museum. The Science Museum, while remaining one of London's greatest holiday attractions, has become one of its greatest educational institutions.

Lyons retired from the Science Museum in 1933 and was then free to devote himself to the voluntary work which had occupied so much of his time even while holding official posts. Varied as had been his official work, equally varied was the services he gave voluntarily to science and other interests. These probably occupied as much of his time, after returning to England in 1906, as his paid posts. It is quite impossible even to mention them all here, so I will confine myself to a few of which I had personal knowledge.

I first corresponded with Captain Lyons, as he then was, in 1913 or 1914, when I was engaged in India on writing up the meteorological results of Scott's Antarctic Expedition, 1910–12. As secretary to the committee appointed to publish the scientific results of the Expedition, Lyons was responsible for organizing the staff engaged on the work, and he supervised the printing and publication of the resulting books and monographs. It was a big undertaking and all of us engaged in the task were grateful to him for his helpful interest in our work. The imposing array of volumes containing the scientific records of the Expedition is a lasting monument to his disinterested zeal for science.

When I became director of the Meteorological Office in 1920, Lyons was one of the two representatives of the Royal Society on the Meteorological Office Committee, of which he was a member for twenty-three years (1918–41). The senior representative of the Royal Society is always the vice-chairman of the Committee (the Under-Secretary of State for Air being the permanent chairman) and generally presided at the meetings. Sir Henry became vice-chairman on the retirement of Sir Arthur Schuster in 1932. At the meetings and between meetings Lyons was always helpful; his short term as administrator of the Office had given him an insight into the difficulties with which the director has to contend, and his advice was always good and willingly given.

Sir Henry also succeeded Sir Arthur Schuster in 1928 in a much more important voluntary office, namely, the secretaryship of the International Council of Scientific Unions. It was a great piece of good fortune for international science that these two able Englishmen should have directed the work of the Council for the first eighteen years of its existence (1919–37). Lyons' great administrative ability, perfect command of the French language and unfailing good temper were valuable assets in guiding the Union through the difficult time between the two world wars, when international relationships were not easy.

The great work which Sir Henry has done for the Royal Society, as foreign secretary and treasurer, has been recorded by the president of the Royal Society (*The Times*, August 12). He was not just a good treasurer, he pulled to pieces and built anew the whole financial side of the Society's business. In this work his bent for science, his pride in the Society and his love of administration all found scope, and the result is worthy of a great Society and of a great administrator.

I cannot detail the work Lyons did for the Geological, Royal Geographical and Royal Meteorological Societies—he was a fellow of the first, a secretary of the second and president of the third; it is sufficient to say that he left his mark on all three. Needless to say he received many honours, including the Grand Cordon Medjidieh, 2nd class Osmanieh, Hon. D.Sc. Oxon., Hon. D.Sc. Dublin, F.R.S., knighthood (1926) and several medals awarded by scientific societies.

It was not, however, his great ability which endeared Lyons to those who came in contact with him; it was his utter absence of affectation, his friendly greetings and pleasant smile. Everyone who knew Lyons even slightly feels a loss in his death on August 10, and those of us who knew him well realize that we have lost a friend who cannot be replaced.

Sir Henry Lyons was the son of General T. C. Lyons, C.B., and married Helen Julia, eldest daughter of the late Mr. P. C. Hardwick in 1896. Lady Lyons was often with Sir Henry on his visits to international meetings and at official ceremonies, and was equally successful as hostess or guest. Our sympathy goes out to her and to their son and daughter in their great bereavement. G. C. SIMPSON.

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WE regret to announce the following deaths:

Dr. Agnes Bluhm, an authority on social hygiene and heredity, of the Kaiser Wilhelm Institute for Biology, Berlin-Dahlem, aged eighty-one.

Mr. A. Deane-Butcher, C.B.E., formerly director-general of irrigation, Sudan and Southern Nile, on August 21, aged sixty.

Dr. Ethel Miles Thomas, formerly head of the Department of Botany in University College, Leicester, on August 29.

Sir Arthur Smith Woodward, F.R.S., keeper of geology in the British Museum (Natural History) during 1901–24, on September 2, aged eighty.

# NEWS and VIEWS

## Chair of Social Institutions, University of London

As announced in *Nature* of August 13, p. 206, Mr. T. H. Marshall has been appointed to the newly instituted University chair of social institutions tenable at the London School of Economics. This chair has a double function. Within the general field of sociology the professor will be responsible for promoting the study of modern social structure, which includes both analysis of the functions of social institutions and investigation into the character and composition of social groups. At the same time, Mr. Marshall succeeds Mr. C. M. Lloyd as head of the Social Science Department. This Department has grown steadily in size and range under Mr. Lloyd, and has been working to capacity throughout the War to meet the demand for trained social workers. But the development and expansion of the social services is likely to be even greater after the War, and universities will be under pressure to take more students and to train them more rapidly. In such circumstances great care will be needed to ensure that quality is not sacrificed to quantity, and to prevent any deviation from the twofold aim of raising the academic status of the Social Science Department within the University and raising the professional status of the trained social worker in the world outside. An important step in this direction can be made by integrating the work of the Social Science Department more closely with that of the other departments of the School. The dual character of the new chair should make this easier than it has been in the past. Mr. Marshall is at present reader in sociology in the School.

## Dr. James Philp

Dr. James Philp has been appointed director of research for the South African Wattle Growers' Union, Pietermaritzburg. He is also acting in an advisory capacity to the Forestry Division of the South African Government, with which he was previously engaged as its first forest geneticist. Dr. Philp was on the staff of the John Innes Horticultural Institution, Merton, until 1934, and during the succeeding eight years was in charge of the cereal division of the plant breeding section of the Egyptian Ministry of Agriculture.

## Medicine in Turkey

The July issue of the *Asiatic Review* contains an interesting article on the history of medicine in Turkey by Dr. H. Avri Aksel, chief surgeon to the Haseki Hospital, Istanbul, and a member of the Turkish Medical Mission which recently visited Great Britain. He points out that Turkish medicine, which has a history of six hundred years, is a continuation of the medicine of the Selcuk Turks who for centuries ruled in Anatolia and left a great many traces of their civilization. In the middle of the fourteenth century, the rapid expansion of the Turkish Empire and particularly the respect paid by the Sultans and their viziers to science and scientific men was the cause of Turkey being flooded by a great many men of science from Persia, Egypt, Irak and India. The number of hospitals increased and rose to fifty after the conquest of Istanbul. The medicine of the early days was very elementary, being rather a system of master and apprentice rather than a science taught in the schools, and knowledge was gained by practical experience.

The sixteenth century was the most brilliant age. Science and art reached great heights. Medicine was taught to students in well-organized courses, and for the first time lessons on anatomy were given. At the end of the seventeenth century, Turkish medicine gradually moved from the East and turned towards the West. Turkish medical men who went to Europe with the armies learnt European languages, translated important medical works into Turkish and introduced new methods. The eighteenth century was very important owing to the practice of inoculation against small-pox having begun in Turkey before it did in Europe. In the nineteenth century a big advance in surgery and medicine took place in Turkey. All the new methods employed in European medical colleges were applied. Anatomy for the first time was taught on the human body and a large library was established. There are now about two hundred hospitals in Turkey, innumerable maternity and child welfare centres, and a great many dispensaries and hospitals for infectious diseases and tuberculosis. There are altogether four thousand medical practitioners in private practice and in the service of the State.

## Carnegie United Kingdom Trust

The thirtieth annual report of the Carnegie United Kingdom Trust for the year 1943 (The Trust, Dunfermline) records a year of quiet progress and consolidation, the total grant expenditure showing, for the first time during the War, a decrease, from £69,000 to £62,000. This was due to the transfer to the Council for the Encouragement of Music and the Arts of financial responsibility for large orchestras and opera, the diminution or withdrawal of many of the salvage grants made early in the War, as well as of certain maintenance grants renewed on a diminishing scale, and the improved financial position of beneficiaries who have been offered grants on a deficiency basis. Grants for the equipment of youth clubs increased from £5,695 in 1942 to £9,178 in 1943; but conditions in the book trade have compelled the termination of the limited club library policy operated since 1940 for the benefit of new clubs. A preliminary report on an inquiry into conditions of unemployed young men in Liverpool, Glasgow and Cardiff was published in November under the title "Disinherited Youth", and a report on the Trust's bursary scheme for training youth leaders was also published during the year and circulated chiefly among central and local education authorities and voluntary organizations concerned with the welfare of young people. Grants were continued during 1943 in aid of the administration of the Land Settlement Association, the Museums Association, the National Council of Social Service, and the Rural Development Council of Northern Ireland as well as towards the maintenance of the three central libraries.

## Origins of Garden Vegetables

Vilmorin's production of biennial, red-rooted carrots from annual white-rooted wild plants, and Buckmaster's improvement of the wild parsnip, are two outstanding examples of vegetable introductions during the last century. These, and other interesting historical sketches of vegetable introduction, are detailed in a paper by W. F. Giles (*J. Roy. Hort. Soc.*, **69**, Pts. 5 and 6, May and June 1944). Peas apparently originated in the East; the Greeks grew the

crop in 300–400 B.C. Gerarde referred to several kinds of round-seeded pea at the end of the sixteenth century. It was not, however, until nearly two centuries later that Thomas Andrew Knight introduced the sweeter and more palatable varieties with wrinkled seeds. Scarlet runner beans were introduced from unknown antiquity in South America in 1633. Broad beans came from the East, their use there being of great known antiquity. The tomato was brought to Europe in the fifteenth century, but it has only been improved and attained popularity within the lifetime of our elders. Mr. Giles demonstrated the close affinity of various Brassicas with the wild *B. oleracea* by crosses, which all produced fertile hybrids of great morphological variability, but only incipient horticultural promise.

## New Contagious Disease in the United States

A NEW contagious disease with symptoms so mild the sickness may go unnoticed has recently been reported by Dr. Carl H. Smith, of Cornell University Medical College and the New York Hospital. The chief feature of the disease is an increase in the lymphocytes of the blood. Although the number of these white cells may be increased almost ten-fold, they are not abnormal. Fever and vomiting, pain in the back of the head and neck, or pain in the abdomen suggestive of appendicitis may occur in this new disease, but when they do, these symptoms last only a few days. In one case Dr. Smith reports, the child had fever, vomiting and abdominal pain, but a brother and sister had only symptoms of a mild cold. Only since 1939 have cases of this disease, called acute infectious lymphocytosis, been reported. The cause has not been identified, but is believed to be a virus. The disease apparently attacks young children chiefly, and they all seem to recover.

## Use of Inter-city Telephone Circuit for Television

ACCORDING to a recent announcement by the American Telephone and Telegraph Company (*Bell Lab. Rec.*, 22, No. 9; May 1944) plans have been made for the construction of a large amount of coaxial cable to be operated by radio relays. Tentatively, the coaxial extension plans call for the installation of 6,000–7,000 route miles of coaxial facilities in the next five or six years to help meet expected increasing demands for long-distance telephone service. These facilities would be suitable for interconnecting television stations for network operations. Work on the 295-mile Atlanta to Jacksonville route is in progress, and is expected to be in service for telephone purposes by the spring of 1945. Present coaxial equipment will provide television channels of 2,700,000 cycles in width. Tests have shown this equipment capable of transmitting the visual images with satisfactory clearness. Further technical improvements will make it possible to use a much wider band of frequencies, which will permit simultaneous use of the same coaxial for an improved (4,000,000 cycles) television channel and a large number of telephone messages.

The New York-Philadelphia cable, containing two coaxials, was installed in 1936 for further experiment. Its use for transmitting visual images for television broadcasts was first demonstrated in 1937. The cable recently has been providing telephone circuits. The first commercial installation was the Stevens Point-Minneapolis cable, containing four coaxials, two being in regular use and two in 'stand-by' use. This is capable of providing 480 telephone circuits with its present amplifiers. It is now equipped to handle nearly a hundred circuits and soon will be stepped up to about 150. One of the cables now in use between Philadelphia and Baltimore and another between Baltimore and Washington contain coaxials which, however, have not yet been equipped for service. The former contains six coaxials and the latter four. As many as six or eight coaxials are likely to be built into some of the new cables. In a six-coaxial cable, for example, with the present amplifying equipment, two coaxials could be used to provide 480 telephone circuits, another two could provide either two one-way television channels or 480 more telephone circuits, and the others would serve as equipped stand-by circuits to protect both services.

## Engineering Research in the U.S.S.R.

VOL. 1, No. 2 of the *Engineering Review* (Russian) (dated 1941) contains a collection of papers dealing with the mathematics of stress calculations for rotating disks, springs and conical shells. Other papers in the applied mechanics section describe very large mechanical testing machines and an electrical analogy for the investigation of torsion in bars. The hydrodynamics section has papers on filtration in non-homogeneous soils and the unsteady flow of water in canals. A short summary of each paper is given in English or German.

## Marine Water-Tube Boilers

A SERIES of papers read before the Institution of Naval Architects on May 10, 1944, dealt with the design of water-tube boilers for marine propulsion. Designs and data were submitted by Messrs. Babcock and Wilcox, Ltd., International Combustion Co., Ltd., La Mont Steam Generator, Ltd., and Yarrow and Co., Ltd., for a boiler plant suitable for a ship of 7,500 shaft h.p., using oil fuel. The complete set of papers provides a unique opportunity for direct comparison of the designs of modern boilers which should be of great value to marine engineers.

## Announcements

PROF. J. A. SCOTT WATSON, agricultural attaché at the British Embassy in Washington, has been appointed to the newly created post of chief education and advisory officer to the Ministry of Agriculture.

AT a recent meeting of the Geological Society of London, it was decided provisionally to admit persons between the ages of eighteen and twenty-three as junior associates. Such junior associates will enjoy most of the facilities offered by the Society, except that they may not attend discussions relating to the management of the Society's affairs, and they will not be entitled to vote at any meeting; they will not continue as junior associates after the close of the calendar year in which they become twenty-three.

MR. W. BOWEN, of the Bowen Instrument Co., Ltd., has made a gift of £5,000 to the Scientific Instrument Manufacturers' Association of Great Britain for the establishment of a fund to provide prizes for the best annual contribution to instrument research, development or design.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Non-antigenicity of Gelatin

INTEREST in the inability of gelatin to act as a full antigen, that is, to produce specific anti-bodies when injected into an animal, has been revived by the observations of Haurowitz, Tunca and Schwerin[1], and also by the suggested use of isinglass for blood transfusion[2]. Haurowitz *et al.* find that whereas the intravenous injection of arsanil-azo-globulin into rabbits leads to the deposition of the bulk of the arsenic in the liver and bone-marrow[3], the injection of arsanil-azo-gelatin is followed by rapid excretion of the arsenic in the urine with very little deposition in the liver. The conclusions reached by these authors is that arsanil-azo-gelatin does not act as a full antigen because it is insufficiently deposited in the reticulo-endothelial cells of the body.

The non-antigenicity of gelatin may, however, be due to more than one factor, and at least four possible explanations have been or can be offered for the *in vivo* immunological inertness of this protein (cf. Wormall[4]), namely: (1) gelatin is relatively deficient in aromatic groupings; (2) it is deficient in carbohydrate groupings; (3) it may be rapidly excreted in the urine after intravenous injection into an animal; (4) it is usually prepared from collagen by prolonged treatment with boiling water or steam, and this treatment may well be sufficient to destroy any antigenic power of the preparation.

The introduction of aromatic groupings, including tyrosine, into gelatin does not produce a compound which has antigenic powers comparable with those of the majority of other proteins[5]. Thus, although some of these conjugated gelatin derivatives produce antibodies which react with the corresponding conjugates prepared from globulin and certain other proteins, these antibodies react very feebly or not at all with the gelatin derivatives; the results suggest that the non-antigenicity of gelatin is not due solely to lack of aromatic groupings. Similarly, the failure does not appear to be due solely to lack of tyrosine plus carbohydrate[6].

The third explanation given above receives strong support from the observations of Haurowitz and his colleagues, and it seems possible that the major part of injected gelatin or gelatin derivative is so rapidly excreted in the urine that little remains in the body to incite antibody formation. Gelatin and several other proteins with molecular weights less than 70,000 are rapidly excreted in the urine by anæsthetized cats and rabbits and by isolated perfused kidneys of dogs[7]. On the other hand, proteins such as egg albumin and the Bence-Jones protein, both of which are excreted by the kidney, are known to be fully antigenic; thus loss by excretion in the urine is probably not the only factor which determines the non-antigenicity of gelatin.

The fourth possible explanation can be excluded if it is shown conclusively that native collagen is non-antigenic, but unequivocal proof of this does not appear to be available. Glue is devoid of antigenic activity[8], and so is isinglass, "which is a collagen rather than a gelatin"[2]. Apart from these observations, however, it appears that little attention has been given to the parent protein as distinct from the partially hydrolysed product, gelatin. It would seem desirable that a more complete immunological study should be made of the antigenic properties of the natural unhydrolized collagens. Such an investigation might certainly help to throw some light on the vexed problem of the antigenicity of proteins.

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[1] Haurowitz, F., Tunca, M., and Schwerin, P., *Biochem. J.*, **37**, 249 (1943).

[2] See Taylor, N. B., and Moorhouse, M. S., with Stonyer, A. J., *Canad. Med. Assoc. J.*, **49**, 251 (1943). Pugsley, H. E., and Farquharson, R. F., *Canad. Med. Assoc. J.*, **49**, 262 (1943). Cited from *Bull. War Med.*, **4**, 464 and 465 (1944).

[3] Haurowitz, F., and Kraus, F., *Hoppe-Seyl. Z.*, **239**, 76 (1936). Haurowitz, F., *Hoppe-Seyl. Z.*, **245**, 23 (1937).

[4] Wormall, A., *St. Bartholomew's Hosp. Reports*, **70**, 199 (1937).

[5] Landsteiner, K., *Biochem. Z.*, **93**, 106 (1919). Hooker, S. B., and Boyd, W. C., *J. Immunol.*, **24**, 141 (1933). Hopkins, S. J., and Wormall, A., *Biochem. J.*, **27**, 1706 (1933). Clutton, R. F., Harington, C. R., and Yuill, M. E., *Biochem. J.*, **32**, 1111 (1938).

[6] Clutton, R. F., Harington, C. R., and Yuill, M. E., *loc. cit.*

[7] Bayliss, L. E., Kerridge, P. M. T., and Russell, D. S., *J. Physiol.*, **77**, 386 (1933).

[8] Ramsdell, S. G., and Walzer M., *J. Immunol.*, **14**, 207 (1927).

## Capacity of Hyaluronidase to Increase the Fertilizing Power of Sperm

THE capacity of hyaluronidase to liquefy the highly viscous gel which cements the cumulus cells around the unfertilized tubal egg of the rat was described by McClean and Rowlands[1], and confirmed in the mouse by Fekete and Duran-Reynals[2] shortly afterwards. We suggested that the gel is hyaluronic acid similar to that in synovial fluid and, to enable its disintegration to occur as a preliminary to fertilization, a certain unspecified concentration of hyaluronidase must be established by the sperm in the vicinity of the egg. The fact that intromission of such a large number of sperm is necessary to ensure fertilization, therefore, may well be related not only to the safe passage of one or more sperm into the Fallopian tube but also, and possibly more especially, to the establishment of this requisite concentration of enzyme. Some preliminary experiments, which are described below, have now been carried out in rabbits to investigate the capacity of hyaluronidase to increase the fertilizing power of dilute sperm suspensions.

Ovulation was induced in Dutch and Himalayan rabbits by intravenous injection of 50 I.U. of chorionic gonadotrophin. A mixed sample of semen from 8–12 rabbits was collected in an artificial vagina and its sperm-count estimated using a Zeiss hæmocytometer. The semen was then diluted in Baker's[3] solution so as to contain $2 \times 10^7$ sperm per c.c., and from this were then prepared (1) further dilutions to give suspensions of sperm varying between $2 \times 10^6$ to $2 \times 10^4$ per c.c., and (2) a hyaluronidase-containing filtrate of the sperm, the latter having been inactivated by heating at 50° C. for 5 min. and separated by vigorous centrifugation. This sperm-free filtrate was then mixed in equal proportions with the various sperm suspensions and 2 c.c. of the mixtures inseminated artificially into each rabbit at approximately 7 hr. after the injection of gonadotrophin, that is, 4 hr. before the expected time of ovulation. Sperm counts were again made wherever practicable on the inseminates. The amount of hyaluronidase in the semen, and when possible also in the inseminates, was estimated by its capacity to prevent the appear-

ance of a mucin clot on the addition of acetic acid to a freshly made substrate containing 1 per cent horse serum albumin and 0·25 per cent of a standard preparation of potassium hyaluronate extracted from human umbilical cord. Enzyme activity is expressed in mucin clot prevention (m.c.p.) units. Details of the assay method have been published by McClean[4]. Filtrates of $2 \times 10^7$ sperm were found to contain 4–8 m.c.p. units per c.c.

Fertilization was determined by the presence of multi-cellular ova in washings of the Fallopian tube examined under a dissecting microscope. The rabbits were killed 36 hr. after ovulation when the normal fertilized egg consists of 8–16 blastomeres. The expected number of eggs can be ascertained by counting the number of ovulated follicles in the corresponding ovary; the full complement was almost invariably recovered. A normal rate of segmentation was observed, so that unicellular eggs were, therefore, considered to be infertile.

In all, seven experiments, as outlined above, were made. Two of these were carried out to determine the approximate number of sperm necessary for fertilization. The results, which agree well with the observations of Walton[5], indicate that for maximum fertility $1 \times 10^6$ or more sperm are required, that only a small number of eggs become fertilized when the inseminate contains $2 \times 10^5$ sperm, and that $1 \times 10^5$ sperm are probably incapable of causing fertilization. The approximate median effective concentration of sperm varies from $4{\cdot}47 \times 10^5$ to $1{\cdot}82 \times 10^6$. Of five experiments in which hyaluronidase (filtrates of $2 \times 10^7$ sperm) was added to the inseminates, four showed that the enzyme was effective in increasing fertility. In these four experiments the median effective concentration of sperm varied between $5{\cdot}44 \times 10^4$ and $1{\cdot}52 \times 10^5$. In one experiment hyaluronidase was ineffective. Inseminates containing $2 \times 10^4$ sperm with added enzyme were found to be incapable of causing fertilization. Taken together, the tests show that although the action of hyaluronidase is very variable under the conditions tested, it increased the fertilizing capacity on the average to the extent that treated groups required about one sixth of the sperm concentration to give a 50 per cent response, compared with that in control groups. The range covered was, however, from one thirtieth to equality of concentration in different tests. The probability that the enzyme in fact facilitates fertilization is of the order of at least 50 to 1 in favour.

At this stage of the investigation any discussion as to the method by which the enzyme, even in the absence of a vector, reaches the Fallopian tube would be purely speculative. A rapid spreading action of the enzyme through the lumen of the female reproductive tract similar to that through the skin and subcutaneous tissue would, however, seem to be ruled out by the unpublished observation of McClean that hyaluronidase does not lower the viscosity of cervical mucin. If one assumes, therefore, that this enzyme does not assist in the conveyance of sperm, these experiments incidentally may throw some light on the number of sperm required to be inseminated in order that one or more may reach the Fallopian tube. It is possible that not one of those in the inseminate containing $2 \times 10^4$ sperm reaches the tube, and that the number of those in the inseminate estimated to contain $1 \times 10^5$ that do, in the absence of added enzyme, is so small that the concentration of hyaluronidase they are able to establish locally is not sufficient to liquefy the gel protecting the egg.

Further investigations are now proceeding into the role of this enzyme in fertilization and its relationship to infertility associated with oligospermia.

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[1] McClean, D., and Rowlands, I. W., *Nature*, **150**, 627 (1942).
[2] Fekete, E., and Duran-Reynals, F., *Proc. Soc. Exp. Biol. N.Y.*, **52**, 119 (1942).
[3] Baker, J. R., *Quart. J. Exp. Physiol.*, **21**, 139 (1931).
[4] McClean, D., *Biochem. J.*, **37**, 169 (1943).
[5] Walton, A., *Proc. Roy. Soc.*, B, **101**, 303 (1927).

## Abrasion of Soil Insects

IN a recent preliminary note[1], evidence was given to show that abrasion of the superficial layer of wax on the epicuticle would go far to explain the action of inert dusts in causing insects to dry up; and confirmation of these ideas was published by Kalmus[2].

It may be of interest to point out that the permeability of insect larvæ living in the soil can be similarly explained by the abrasion of the cuticle by soil particles. Larvæ of Hepialus and Agrotis, Pterostichus, Agriotes, Aphodius and Phyllopertha, Bibio and Tipula when treated with ammoniacal silver all show obvious scratches. In the caterpillars Hepialus and Agrotis, the scratches occur chiefly on the prominent folds along the sides of the body and the outer surfaces of the true legs. In the scarabaeids Aphodius and Phyllopertha it is the lateral folds, the terminal segment and the rounded back that are most scratched. In the larva of the carabid Pterostichus, the sclerites show many longitudinal scratches; the soft intervening cuticle may be almost uniformly abraded except where it is thrown into depressed folds.

In the wireworm Agriotes, the rate of water-loss varies in direct proportion with the degree of visible scratching. But if the wireworm is allowed to moult out of contact with the soil, it is found to possess a cuticle impermeable to water like that of other

PART OF THE CUTICLE OF A WIREWORM TREATED WITH AMMONIACAL SILVER. REDUCTION BY THE EXPOSED PHENOLS REVEALS THE EXTENSIVE SCRATCHING OF THE SURFACE.

insects. Thus at 20° C. the average rate of evaporation from the wireworm into dry air is about 10·5 mgm. per sq. cm. per hour. In a larva kept out of contact with the soil for ten days after moulting, the rate was 0·4 mgm. per sq. cm. per hour. These observations will account for the fact that the normal wireworm cuticle, though highly hydrophobe, is readily permeable to water[3]. They may have a bearing on the entry of insecticides through the cuticle of soil insects[4].

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[1] Wigglesworth, *Nature*, 153, 493 (1944).
[2] Kalmus, *Nature*, 153, 714 (1944).
[3] Evans, *Nature*, 152, 21 (1943).
[4] Woodworth, *J. Agric. Res.*, 57, 229 (1938).

## Paracrinkle Virus and Inheritance

IN his recent interesting article[1], Dr. Darlington speculates on the origin of viruses and in particular on that of paracrinkle virus in the potato variety King Edward. He states with reference to paracrinkle that "what is a stable and presumably useful cell protein with one plant genotype acts as a destructive agent with another"; also that "any virus that can be transmitted only by grafting must therefore have arisen from grafting; that is to say, from the invasion of one plant by the proteins of another". We gather from this that Dr. Darlington considers that a protein constituent of King Edward becomes a virus on transference by grafting to another potato variety. While this is a tempting speculation, whatever evidence there is does not support it, and we should like to point out the following facts.

First, unlike the plasmagenes, the paracrinkle virus is not transmitted through the seed. Thus, twenty-two seedlings from the cross King Edward female × Flourball were tested by grafting on Arran Victory, and in no case was the paracrinkle virus present in the seedlings. Paracrinkle thus behaves like the majority of plant viruses and not like a plasmagene.

Secondly, paracrinkle can be transmitted by grafting to certain potato varieties which carry it without symptoms, for example, President. From such infected President plants other susceptible varieties such as Arran Victory can also be infected in series.

There thus seems no fundamental difference in the reaction of King Edward to paracrinkle virus from that of any other 'carrier' variety to the virus 'carried'.

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Aug. 14.

[1] *Nature*, 154, 164 (1944).

## The Melanic Form of *Rattus norvegicus* in London

RECORDS of the melanic form of *Rattus norvegicus* from various parts of the British Isles have been published since Thompson[1] in 1837 first described it as a new species under the name of *Mus hibernicus*. There is very little information about the frequency of melanism at any time in the wild population, and it is therefore impossible to draw an accurate picture of changes taking place in the status of the two forms in recent years. The matter is of interest from an evolutionary aspect, and also from the point of view of rodent control, where, since it is necessary to distinguish between colonies of the black rat, *R. rattus*, and those of the brown rat, *R. norvegicus*, it is desirable to know of the existence and status of melanism in the latter species.

The melanic form is superficially very similar to the black rat, *R. rattus rattus*. It is very dark brown, almost black in colour; but unlike the black rat, which is distinctly paler on the belly than on the back, it is scarcely noticeably lighter on the underside. Some individuals have a white patch on the chest or belly; but this varies considerably in size and shape. In all its structural characters it is identical with *R. norvegicus* and can easily be distinguished from *R. rattus rattus* by the small ears, short tail and absence of long guard hairs on the back.

I examined a sample of the rats caught in the Port of London during the two years Sept. 1941–Sept. 1943, together with a number from a large riverside factory in Woolwich in the second of these two years. The majority of these rats were *R. rattus*, but the sample included 1,266 *R. norvegicus*. The sample was drawn from the six dock areas: the London and St. Katharine Docks, the Surrey Commercial Docks, Regent's Canal Dock, the India and Millwall Docks, the Royal Docks, and Tilbury Dock, as well as from the factory already mentioned. These may fairly be considered as a representative section of the riverside districts of London, so that these rats may be said to constitute a fair sample of the rodent population of this district. They are all, with the exception of Tilbury, which is outside London, surrounded by warehouses, bombed sites and dwelling-houses which are typical of this riverside, and the rodents' environment is probably similar throughout the area.

| Locality (riverside) | No. of *R. norvegicus* examined | No. of melanics found |
|---|---|---|
| London and St. Katharine Docks .. | 115 | 2 |
| Surrey Commercial Docks .. .. | 337 | 0 |
| Regent's Canal Dock .. .. | 138 | 4 |
| India and Millwall Docks .. .. | 98 | 1 |
| Royal Docks .. .. .. | 406 | 11 |
| Woolwich factory .. .. .. | 90 | 2 |
| Tilbury Dock .. .. .. | 82 | 1 |
| Total .. .. .. .. | 1,266 | 21 |

The percentage of melanics in the sample as a whole was 1·66 per cent.

The melanics appear to be uniformly distributed along the riverside. The figures were examined for homogeneity by P. H. Leslie; the variation in the proportion of melanics between the different areas is not in any case significant, and is compatible with variations in random sampling ($\chi^2 = 10{\cdot}25$, $n = 6$, $P = 0{\cdot}20$–$0{\cdot}10$).

Melanic brown rats have also been obtained during the last five years from the following places: Bethnal Green[2], Tooting, Bishopsgate, City Road[3], Leadenhall Market[4], and Dagenham[5], as well as one I found

in the Isle of Dogs. It seems likely that melanism is widely spread throughout the London area.

An incidence of melanism as high as 1·66 per cent cannot be accounted for by mutation and recombination alone. The factors responsible for the appearance of this character must, therefore, be well established in the rat population of this district. Earlier records of the occurrence of the variety in London seem to be practically non-existent. This suggests that the black variety must have appeared here quite recently; if this is so, it is unlikely that a balance has yet been struck between the two phases. *R. norvegicus* is probably in a state of transient dimorphism. Confirmation of this must, however, depend on this work being repeated at some future date.

Little is known about the general distribution and status of the melanic phase in the past. The scanty literature on the subject has been summarized by Barrett-Hamilton[6] and Millais[7]. It is possible that local museums may have a certain number of unrecorded skins in their collections.

I am much indebted to Dr. M. T. Morgan, medical officer of the Port of London Health Authority, for his co-operation and help, and to Dr. Arthur Davies of the Seamen's Hospital Society for his kindness in providing laboratory facilities; and I wish to acknowledge their interest throughout this investigation.

J. S. Watson.

Bureau of Animal Population,
University Museum,
Oxford. July 21.

[1] Thompson, W., *Proc. Zool. Soc. Lond.*, 5, 52 (1837).
[2] Hewer, H. R., "Records of the Bureau of Animal Population Surveys in London".
[3] Information provided by the Ministry of Food.
[4] Information provided by G. A. Webber, rodent officer, City of London Corporation.
[5] Claremont, C. L., letter to Charles Elton.
[6] Barrett-Hamilton, E. G. H., "A History of British Mammals" (London, 1916), 2, 613.
[7] Millais, J. G., "The Mammals of Great Britain and Ireland" (1905), 2, 220.

## A Ciliate from the Dead Sea

A piece of flint-stone, 7 × 7 × 5 cm., was taken by Dr. T. Rayss on August 24, 1940, from the bottom of the Dead Sea near Kalliah from a depth of c. 150 cm. of water and handed to me. On the stone, brown spots and vein-like markings were seen, and when some of the material scraped from the veins was examined microscopically, brown cells of a blue-green alga were observed. The following day the stone was submerged in Dead Sea water of s.g. 1·1875, in a closed glass vessel and exposed to light near the window. It was left standing for three years and four months, during which time no visible change in colour was noticed. However, in the meantime, owing to very slight evaporation, the specific gravity of the water rose to 1·2026, and when once again a hanging drop was microscopically examined, four different types of micro-organisms were revealed. These were identified as follows:

(1) *Aphanocapsa* sp. Cells of a blue-green alga, 3·4 μ × 5–10 μ, appearing singly, in pairs or clumps, and were similar to those previously seen on the stone and found in mud samples from the bed of the Dead Sea[1].

(2) *Dunaliella viridis* Teod. Green flagellates, 2·7 μ × 8–11 μ, varying somewhat from their usual shape, previously described[2], due, no doubt, to the increase in salt concentration. Both flagella arise laterally, one overlaps the anterior end, while the other with which the organism moves extends down beyond the posterior end of the cell.

A ciliate grown in Dead Sea water. Unstained preparation. × 800.

(3) *Amœbæ*. Cells 6–16 μ × 6–27 μ, showing a granulated content, short pseudopodia and slow motility. It still remains to be ascertained whether the organisms are identical with the species of Dimastigamœba previously described[1].

(4) *Ciliate*. Oval shape, 8–13 μ × 16–24 μ, transparent, colourless and having four longitudinal ridges. The organism is very actively motile. The cilia extend around the cell, and two long spines appear at the posterior end. Vacuoles are present; nucleus and cytostome are not visible (see accompanying photograph).

The four different types of organisms were obtained in liquid culture media, exposed to light, containing: 15 per cent salt, 0·03 per cent $Ca(NO_3)_2$, 0·01 per cent $KH_2PO_4$, 0·02 per cent peptone and traces of $FeCl_3$.

The amœbæ and the ciliate were grown in the dark at 30° C., in a semi-solid agar media consisting of the same liquid media plus 0·6 per cent agar; a small amount of sterile rice starch was added after inoculation.

It is of interest to note that the green flagellates, from only one out of a number of liquid cultures normally grown in the light, completely lost their green colour when grown in a semi-solid agar medium in the dark, and so far have failed to regain their colour when re-exposed to light.

Recently, flint-gravel and water of s.g. 1·1848, collected from the shore of the Dead Sea, was exposed to light. After two weeks a number of the green flagellate *Dunaliella viridis* Teod. and a few amœbæ were observed.

Including the ciliate found actively growing in Dead Sea water, the different groups of organisms which have now been found in the Dead Sea are: bacteria, several blue-green algæ, two species of green flagellates, amœba (possibly more than one species), and a ciliate.

Full details will be published elsewhere.

I take this opportunity to thank Dr. T. Rayss, of the Hebrew University, Jerusalem, for the flint-stone she gave me.

B. Elazari-Volcani.

Daniel Sieff Research Institute,
Rehovoth, Palestine.
July 5.

[1] Elazari-Volcani, B., *Nature*, 152, 301 (1943).
[2] Elazari-Volcani, B., "Studies on the Microflora of the Dead Sea" (Jerusalem, 1940).

## Manganese-deficient Soils

IN 1942, Sherman, McHargue and Hodgkiss[1] described a modification of Leeper's[2] method which would identify: (a) manganese-deficient neutral and alkaline soils; (b) strongly acid soils that will become manganese-deficient when limed to near neutrality; and (c) soils that are likely to contain such excessive quantities of available manganese as to be toxic to plants. There is evidence from analyses of English soils that their method may be useful at any rate in identifying the first two classes of soils.

The method described by the above-mentioned authors was slightly modified to ensure easy manipulation and to save time by the use of separate 20-gm. samples of air-dried soil for the three extractions, namely: (1) water-soluble manganese, (2) exchangeable manganese, and (3) easily reducible manganese. This procedure was adopted instead of the single sample used successively for the three extractions. It will be seen from the results that the small quantities of water-soluble and exchangeable manganese in the extract containing the easily reducible manganese made no difference to the general conclusions. The three samples were then shaken for one hour in a rotary shaker with 150 ml. of extracting agents, that is, distilled water, neutral ammonium acetate, and 0·2 per cent solution of hydroquinone in neutral ammonium acetate. The procedure as described by the authors was then followed.

Three types of soil were investigated:

(1) A light, black, heath soil from Shropshire with a strongly acid reaction under natural conditions.

(2) A heavy Lias clay from south Warwickshire with an almost neutral reaction.

(3) A garden loam from the grounds of the University of Birmingham with a *p*H above 7·0.

Manganese-deficient oats were seen growing on the first two soils while healthy oats were growing on the University soils. The Shropshire soils had *p*H values between 6·4 and 7·9 due to heavy liming, and certainly fall into the category manganese-deficient when heavily limed. The Lias soil from Warwickshire had *p*H values between 6·3 and 7·0 and is therefore an almost neutral soil. The high *p*H of the University soil was due to heavy liming.

MANGANESE IN P.P.M. OF AIR-DRIED SOIL

| Source | *p*H | Water soluble | Exchangeable | Easily reducible |
|---|---|---|---|---|
| Shropshire 1 | 6·7 | 1·2 | 1·1 | 8·2 |
| ,, 2 | 6·4 | 0·0 | 1·5 | 5·7 |
| ,, 3 | 7·9 | 0·0 | 0·8 | 5·3 |
| ,, 4 | — | 0·5 | 0·8 | 2·8 |
| Warwickshire 1 | 6·5 | 0·0 | 4·7 | 33·1 |
| ,, 2 | 6·3 | 0·0 | 1·3 | 25·6 |
| ,, 3 | 7·0 | — | 12·3 | 43·7 |
| University 1 | 7·5 | 0·0 | 2·7 | 183·0 |
| ,, 2 | 7·7 | 0·5 | 2·1 | 120·0 |
| ,, 3 | — | 1·5 | 8·9 | 98·2 |
| ,, 4 | — | 1·1 | 9·3 | 113·7 |
| ,, 5 | — | 0·8 | 10·5 | 150·0 |

It is seen from the accompanying table that the easily reducible manganese is the important fraction in identifying manganese-deficient soils. The Shropshire soil had an easily reducible manganese of less than 10 p.p.m., the neutral Lias clay had less than 50 p.p.m. manganese, while the University soil samples all had about or well over 100 p.p.m. of manganese. There is, therefore, further evidence here supporting the conclusion of Sherman, McHargue and Hodgkiss that manganese-deficient soils can be identified by this method.

A survey of soils is of course necessary to establish this method, but should it prove to give results consistent with those of Sherman, McHargue and Hodgkiss and those mentioned here, the method would certainly prove to be useful in advisory work.

E. S. TWYMAN.

Botanical Department,
The University,
Birmingham.
Aug. 3.

[1] Sherman, McHargue and Hodgkiss, *Soil Sci.*, **54**, 253 (1942).
[2] Leeper, *Proc. Roy. Soc. Victoria*, **47** (11), 225 (1935).

## Science and the Fisheries

THIS is truly a subject for the *formidable* speculation with which Prof. James Ritchie has treated it[1]. He dreams of a mountainous, nay astronomical, dash of nutrient chemicals in the North Sea, which is to make a remarkable increase in the growth of fish. And why not ? Greater changes than that have been made on the face of the earth in the past; but scarcely so simply—except in destruction. The southern, shallower part of the North Sea, where the main nurseries are, has been found to suffer from shortage of phosphate in one or two dry years, and there was no shortage in one or two normal years. Sun and warmth are likely limiting factors. In the meantime, transplantation has been successful in increasing fish-growth, on an experimental scale in the North Sea, and on a commercial scale in the Belt Seas.

The rosy picture given of the United States as the land of the free, in freshwater fishery matters, does not now apply to salmon fisheries, nor I think to many other fisheries of a commercial scale. I dislike the word 'restriction': 'moderation' is a better one, and is part of the practice of husbandry.

MICHAEL GRAHAM.

British Liberation Army.
Aug. 19.

[1] *Nature*, **154**, 275 (1944).

## A New Barium-feldspar from Wales

DR. A. W. GROVES recently sent to one of us a specimen of white vein-material found in the manganese ore from the Benallt mine near Rhiw, Carnarvonshire. He suspected the presence of the rare barium-feldspars celsian and paracelsian, which were discovered in the same mine in 1911[1,2]. We found the optical properties of the mineral differed from those of any known barium mineral, and microchemical analysis has now shown that it is a new barium-feldspar and the first example of an alumino-silicate of barium containing sodium as the dominant alkali. The name proposed for the new mineral is 'banalsite', suggested by its chemical formula $BaNa_2Al_4Si_4O_{16}$.

X-ray photographs show that banalsite is orthorhombic with unit-cell dimensions *a* 8·50, *b* 9·97, *c* 16·73 A. and space-group *Iba* or *Ibam*; the observed specific gravity is $d_4^{16} = 3{\cdot}06$, whence the unit cell contents are calculated to be $4BaNa_2Al_4Si_4O_{16}$. No crystal forms are visible on hand specimens, but thin sections reveal indications of a few faces of simple indexes including (110) and (001) both parallel to good cleavage directions. The optic axial

plane of the mineral is parallel to (100), $\alpha = c$, refractive indexes $\alpha = 1{\cdot}5695$, $\beta = 1{\cdot}5710$, $\gamma = 1{\cdot}5775 \pm 0{\cdot}0005$ (sodium light). The optic axial angle measured on the universal stage is $2V$ 41° positive. Face-centred cells can be derived from the unit cells of banalsite and sanidine, which have similar dimensions, probably indicating the similarity of the silicon-aluminium-oxygen network in the two structures.

The banalsite occurs massive associated with tephroite, alleghanyite, jacobsite, baryte and calcite in certain rare veinlets and narrow bands in dark purple manganese ore. The tephroite and alleghanyite form thin blade-like crystals showing parallel intergrowths. The orientation of the crystals in these intergrowths and the chemical and X-ray study confirm A. F. Rogers's work[3] on alleghanyite from North Carolina, which showed that alleghanyite is the manganese analogue of chondrodite, and that it bears the same relation to tephroite as chondrodite does to forsterite.

W. CAMPBELL SMITH.
F. A. BANNISTER.
M. H. HEY.

Department of Mineralogy,
British Museum (Natural History),
London, S.W.7.

[1] Russell, A., *Nature*, **86**, 180 (1911).
[2] Spencer, L. J., *Min. Mag.*, **26**, 231 (1942).
[3] Rogers, A. F., *Amer. Min.*, **20**, 31 (1935).

## α-Tungsten

IN the course of an examination of the coatings formed on the tungsten electrodes of a spark gap and of a film sputtered from the electrodes on to the walls of a glass container, it has been found that both the coatings and the film contained a considerable proportion of α-tungsten in addition to normal body-centred cubic tungsten.

This observation is of interest since the only previously reported occurrence of α-tungsten is in the product from certain methods of electrolytic extraction[1,2]. So far as is known, these are not in commercial use, and the tungsten electrodes themselves did not contain any of the α-form.

Identification was based on the X-ray diffraction pattern. The specimens gave sharp lines, and the cell size, absent spectra and the relative intensities observed for the permitted lines agreed with the published structure[1].

The lattice parameter, measured in a 19-cm.-diameter powder camera, was found to be $5{\cdot}0408 \pm 0{\cdot}0002$ kX. at 18° C., compared with the previously reported value of $5{\cdot}038 \pm 0{\cdot}003$ kX. at 20° C.[3].

Subsequent to this examination it was found that Mr. H. P. Rooksby had also made observations of certain occurrences of α-tungsten, and these form the subject of the accompanying communication.

N. J. PETCH.

Camberley House,
Camberley, Surrey.

[1] Hartmann, Ebert and Bretschneider, *Z. anorg. Chem.*, **198**, 116 (1931).
[2] Burgers and Van Liempt, *Rec. Trav. Chim.*, **50**, 1051 (1931).
[3] Neuburger, *Z. Krist.*, **85**, 232 (1933).

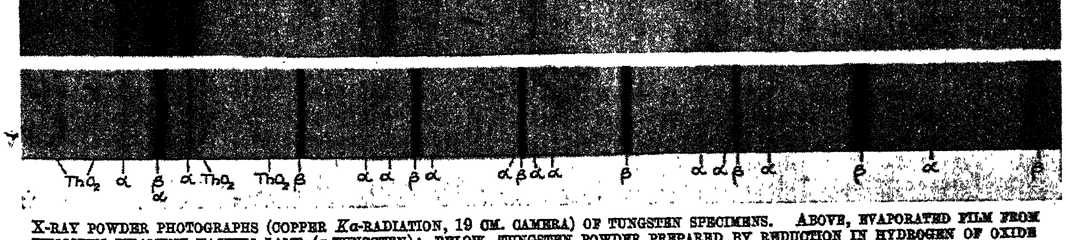
MR. N. J. PETCH has found that the α-form of tungsten occurs in sputtered films and deposits, whereas the only previously reported occurrence was in specimens prepared by electrolytic extraction.

We have also observed this second form of tungsten in the course of examination by X-ray methods of specimens of metallic tungsten from various sources. For example, α-tungsten is often the major constituent of films deposited on the glass envelopes of certain types of vacuum lamps, by evaporation from the tungsten filament. In some instances the α-form appears to be the sole constituent of the volatilized film, but in others it occurs mixed with the normal body-centred cubic form. Phosphorus is usually employed in the lamps that have been examined, for perfecting the vacuum conditions, and it is possible that this has some influence on the structure of the deposited tungsten. No definite evidence which would indicate the effect of the presence of phosphorus is, however, available at present.

Invariably the crystal size of the deposits is so small that the lines of an X-ray powder photograph are diffuse, but even so a sufficient number of reflexions are present for decisive identification of the α-phase. A typical powder photograph of an evaporated tungsten film consisting wholly of the α-phase is shown in the reproduction below.

We have also on occasion noticed the second form of tungsten in powders prepared by reduction of oxide in hydrogen. It has never been found in high concentration in such powders, and the exact conditions of reduction causing its retention have not been explored. But it does appear that impurities such as thoria have some influence. When small percentages of thoria (of the order of 1–2 per cent) are present, the α-phase has been detected in powders that have been reduced at as high a temperature as 800° C., whereas 650° C. has been given as the transition temperature for α-tungsten prepared by electrolytic processes.

The X-ray reflexions for the α-phase in reduced metal powders are sharp, and measurements of the lattice constant give $5{\cdot}041 \pm 0{\cdot}0005$ kX., in very




X-RAY POWDER PHOTOGRAPHS (COPPER $K\alpha$-RADIATION, 19 CM. CAMERA) OF TUNGSTEN SPECIMENS. ABOVE, EVAPORATED FILM FROM TUNGSTEN FILAMENT VACUUM LAMP (α-TUNGSTEN); BELOW, TUNGSTEN POWDER PREPARED BY REDUCTION IN HYDROGEN OF OXIDE CONTAINING 2 PER CENT THORIA (MIXTURE OF β- AND α-TUNGSTEN).

close agreement with Mr. Petch's determination. The X-ray photograph of a tungsten powder containing a proportion of the α-phase is also reproduced in the illustration.

It is apparent from the results described by Mr. Petch and ourselves that the α-form of tungsten may be produced in several ways besides that of electrolytic extraction, namely, by sputtering, by volatilization or evaporation, and, in certain circumstances, by reduction of oxide in hydrogen. The temperature of deposition (or reduction) is probably an important factor in determining the proportion of α-tungsten formed, but the evidence from the examination of volatilized films and reduced powders suggests that impurities such as phosphorus and thoria may also take some part.

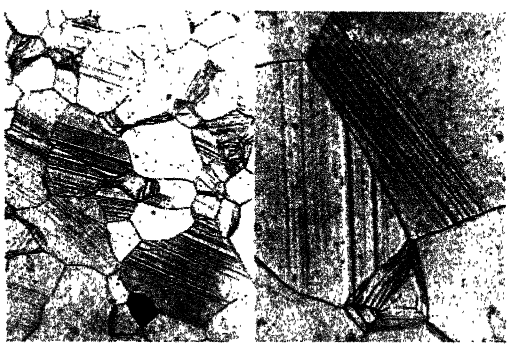
H. P. ROOKSBY.

Research Laboratories of
The General Electric Company, Ltd.,
Wembley.
July 26.

## Thermal Fatigue of Metals

IN our recent communication[1] the photographs as reproduced were placed in the wrong order, so the lettering on them should read *d c b a*—not *a b c d*. There is a progressive *increase* in the deformation and in the grain boundary migration as the number of thermal cycles is increased.

The deformation, as indicated by the formation of slip lines, and the grain boundary migration, are shown more clearly in the accompanying photograph. This illustrates at two different magnifications the numerous slip lines and the grain boundary migration produced in a cadmium specimen after ten very slow cycles between 30° C. and 150° C. The electrolytically polished specimen, which initially was almost free from slip lines, was immersed in an oil bath, and was heated and cooled with it, the duration of a cycle being approximately seven hours. This was done in order to avoid internal stresses due to rapid temperature changes.



(*a*) (*b*)

DEFORMATION IN PURE CADMIUM AFTER 10 SLOW CYCLES BETWEEN 30° C. AND 150° C. (*a*) × 100; (*b*) × 500.

Experiments carried out since our earlier communication have confirmed the view that the deformation observed after cyclic thermal treatment is due to the anisotropy of thermal expansion in the crystals of non-cubic metals.

X-ray back-reflexion photographs show that the lattice distortions produced by the deformation remain in the metal and accumulate as the number of cycles is increased. This is the case for zinc, cadmium and even tin, although in the latter metal the outward signs of deformation are less than in zinc and cadmium. In some cases, recovery occurs after a large number of cycles.

W. BOAS.
R. W. K. HONEYCOMBE.

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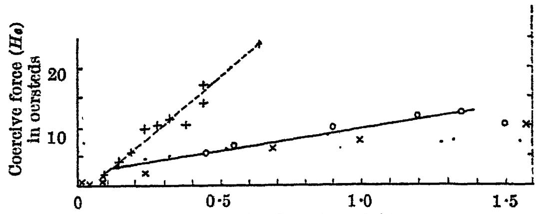
Lubricants and Bearings Section,
University of Melbourne.
June 22.

[1] *Nature*, 153, 494 (1944).

## Relationship between Coercive Force and Carbon Content of Plain Carbon Steels

THE straight-line relation between the coercive force and the carbon content of plain carbon steels has been observed by many investigators. The question arises how far can the relation be carried. The data published by authorities such as Benedicks, Metallografiska Institutet, Stockholm, and Cheney, U.S. Bureau of Standards, have been collected in the International Critical Tables[1]. They used samples containing very small amounts of silicon, manganese, sulphur and other impurities. If their results are plotted we obtain a straight line as shown in Fig. 1.




., Cheney; ○, Benedicks; ×, Gumlich; +, annealed, 850° C.

Fig. 1.

Carbon enters into iron forming pearlite, a structure which can be distinguished from ferrite (iron) under the microscope, when the concentration is more than 0·008 per cent. The amount of pearlite increases as the carbon in iron is increased. If we plot the percentages of pearlite against the coercive forces of the annealed specimens, we obtain the result shown in Fig. 2. The formation of pearlite is complete when the carbon content reaches 0·83 per cent; that is, the eutectoid. After passing the eutectoid, cementite comes into play.

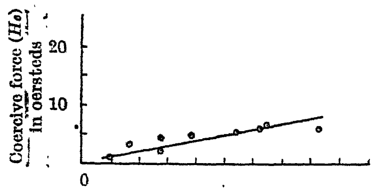



Fig. 2.

When the steel is in a quenched state, the relationship of the coercive force becomes more complicated. It depends on the quenching temperature and the cooling medium. The results from Gumlich are redrawn in Fig. 3.

Recently various applications have been found in this relationship between the coercive force and the carbon content. The instrument, which is known as

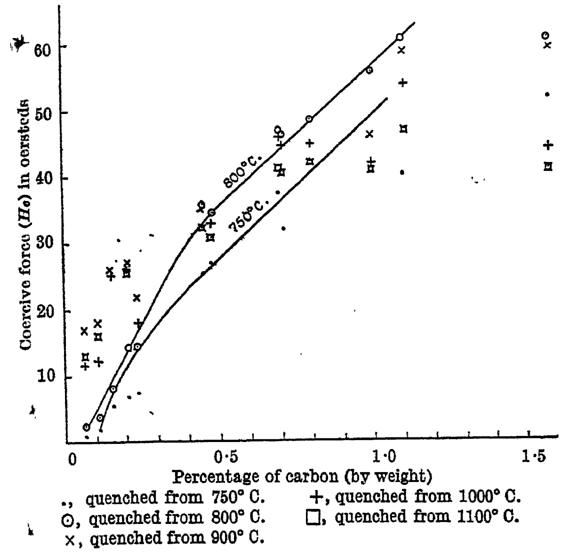



Fig. 3.

a coercimeter, used for the rapid determination of carbon in open-hearth steels, designed by Rogers[2] and his collaborators, may be mentioned as one example. The curve given by them is not explained theoretically, perhaps because the quenching temperature could not easily be controlled. When we compare the curve of Rogers with the curves of Fig. 3, the best quenching temperature range is 800–850° C. This may be taken as the standard range whenever the coercimeter is used in the steel-works.

Many investigators have attempted to correlate the coercivity with the mechanical properties of steels. Metallurgists like Mathews[3] have laid much emphasis on the hardness but have found little success. From the formula

$$H_{c\,\max.} \simeq 3/2.\lambda\sigma_i/I_s$$

derived by Becker[4], I think that the tensile strength is a good measure of the internal strain of the polycrystalline material. The tensile strengths in kgm./mm.² of carbon steels are therefore plotted along the dotted line in Fig. 1. Only those steels in an annealed state and containing low percentages of manganese and silicon are selected[5]. It seems that there is a parallel relation between the tensile strength and coercivity of the ferromagnetic material.

L. C. TAI.

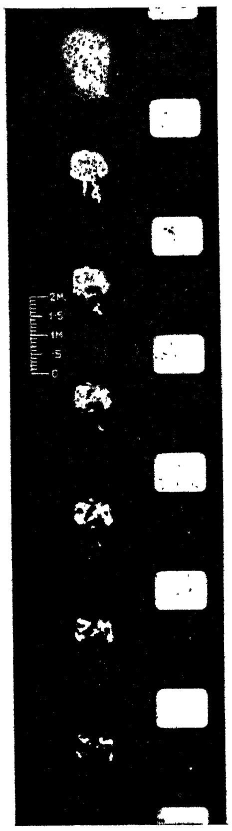
Sanchi, Ki-Kiang,
Szechuan.
June 12.

[1] International Critical Tables, 6.
[2] Rogers, B. A. Wentzel, K., and Riott, L. R., *Trans. Amer. Soc. Met.*, 27, 175 (1939).
[3] Mathews, J. A., *Trans. A.S.S.T.*, 8, 565 (1925).
[4] Becker, R., *Proc. Phys. Soc.*, 52, 138 (1940).
[5] International Critical Tables, 2.

## Persistence of Luminosity in Air

Protracted luminosity occurs naturally in air in at least two forms—aurora borealis and ball lightning. In the case of the aurora, a widely accepted theory is available to account for the energy input which causes excitation. There is, however, considerable doubt as to the corresponding energy mechanism which has been presumed to be necessary to account for the strange stability of ball lightning.

The question arises as to what extent it is necessary to postulate an energy source to explain the sustained luminosity which follows an electrical discharge in air and lasts long enough to be noted by a casual observer. The possibility seems to exist that such a phenomenon can in certain circumstances be described adequately as a purely dissipative process which is simply the aftermath of an intense discharge. The laboratory phenomenon of afterglow is a well-known example of the latter process, as negligible energy is put into the gas by the electrical circuit during the afterglow time. Most of the work on afterglow has been carried out at low pressures where durations of several minutes have been observed, but Meek and Craggs[1] have recently shown that afterglow lasting approximately 30 microsec. can be produced in argon at atmospheric pressure.




EXTINCTION OF 10 KV., 280 AMP. ARC AT NIGHT

In a previous communication[2] the appearance of luminous clouds as a sequel to arc extinction was reported. This aspect of arc extinction has now been examined further, and cloud durations varying from approximately 0·1 to 0·3 sec. have been measured. This phenomenon seems to be a form of afterglow which has some resemblance to ball lightning. It was observed in seven separate tests with currents varying from 90 to 320 amp. at 10,000 volts. Great dissimilarities have been noted in regard to the number, shape and rate of shrinkage of the luminous clouds. Some of the tests were carried out at night and recorded by means of a cine-camera which was used without a light filter. A section of the film is reproduced here; in this the arc current is considered to have ceased between the first and second frames from the top. The camera speed was 32 frames per second.

This work indicates that the energy dissipation following a heavy electrical discharge in air can be arranged to take place so as to provide luminous masses of gas which persist for an appreciable fraction of a second. It is not unreasonable to expect that in certain cases the phenomenon can be observed with the naked eye.

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Science Buildings,
Upper Merrion Street,
Dublin.

[1] Meek and Craggs, *Nature*, 152, 538 (1943).
[2] O'Doherty, *Nature*, 153, 558 (1944).

# RECONSTRUCTION IN WALES

THE first interim report of the Welsh Reconstruction Advisory Council, appointed on June 30, 1942, "to survey, in conformity with the general examination of reconstruction problems now being conducted by the Government, those problems of reconstruction which are of special application to Wales and Monmouthshire, and to advise on them", which has now been issued by the Minister of Reconstruction*, emphasizes that its inquiry is in the nature more of a continuous survey than of an exhaustive examination of specific subjects. The report records the Council's considered opinion as to the state of affairs likely to emerge in Wales after the conclusion of the present War, together with an outline of the kind of measures which will be required in any comprehensive plan for the economic and social rehabilitation and development of the region. It includes a survey of the field already covered by the Council during its first year's work and an indication of the nature of the work which remains to be done.

The first part of the report includes a historical retrospect which emphasizes that the Welsh people claim that experience of the past shows that plans must be made in advance as an essential part of the war effort. The Committee is also insistent that this matter of preparation for the future should not be dissociated from the life of the people affected by entrusting the whole task to any remote central body of experts. In broad outline, at least, such planning must be the function, if not of the people themselves, at any rate of those who know the needs of the people and of the areas.

This part of the report, which clearly owes something to the "Second Industrial Survey of South Wales", makes five major assumptions which underlie all the Council's discussions and recommendations: (*a*) that the War will result in a victory for the United Nations; (*b*) that the War against Germany will end first and hostilities will consequently taper off rather than cease abruptly; (*c*) that sooner or later there will be in Great Britain as a whole, and in Wales in particular, a considerable body of labour to be re-absorbed into peace-time occupations, and an economic situation of sufficient difficulty to demand exceptional measures, planned in advance; (*d*) that the Government's policy will be directed primarily to the maintenance of a high level of employment; and (*e*) that for a considerable period after the end of the War sufficient control will be maintained over the disposition of essential raw materials, plant and equipment, labour supplies (including demobilization) and the utilization and construction of factory premises to avoid the worst excesses of a 'first come, first served' scramble.

The post-war demand for labour in Wales will be determined by the future course of international trade and by the nature and extent of the home market demand. Certain further assumptions are made with regard to both these factors, and the report then emphasizes that there are other fundamental questions of national policy which will condition any regional plan and concerning which any assumptions are unwise in the absence of decisions by the Government. For example, in regard to planning, the interests of Wales will not be served unless the central planning authority to be established accepts and acts upon the principle of decentralization and devolves very large powers upon regional bodies, the activities of which will be co-ordinated by the central authority. Any new Welsh regional economic planning authority must be organized along lines that are at once flexible and powerful.

Reviewing the five phases through which post-war reconstruction in Great Britain as a whole may be expected to pass—momentary dislocation, first reconstruction boom, general prosperity, turn of the tide, and second reconstruction effort—the Council points out that the greatest danger of the first boom period is that it will encourage in Wales an attitude of complacency, leading to the deferment of thought about the need for fundamental changes in the basic industries (or even the denial of the need for them), together with a failure to take urgent steps to broaden the industrial basis. It also emphasizes the strictly temporary nature of war-time prosperity in Wales: between forty and fifty per cent of all the workers employed by new industries in a large sample area covering nearly half the population of Wales were shown in two recent surveys to be attached to establishments which must almost inevitably either close down or drastically curtail their activities at the end of the War.

Furthermore, there are four potential danger spots which are discussed in some detail. The first of these is the possibility that technological unemployment consequent upon the introduction of strip-mill methods of production in the tin-plate industry at Ebbw Vale, and the necessity to adopt such methods in the west central and western anthracite areas will lead to the emergence of a new set of depressed areas. This is an industry in which there is every reason to anticipate drastic reorganization, rationalization and considerable technological unemployment. It would be fatal to oppose a technical development which has become a necessity if the competitive power of the Welsh industry in world markets is to be maintained, but the Council recommends that careful regard should be had to any means whereby the old works can be used as subsidiary to the new strip mills. The necessary reorganization and concentration will also require agreement between the interests concerned, and this may present difficulties unless undertaken as part of the post-war reconstruction plans.

The second danger is that insufficient thought may be given to the need to make provision in the mining industry for the situation likely to be caused by the post-war closure of uneconomic pits and the early exhaustion of others. For this reason the Council recommends as a matter of urgency that all necessary steps be taken to ensure the availability of a survey of coal resources with the view of deciding the most suitable locations for development. The third danger lies in the existence in a number of areas of former mining and metallurgical townships which have completely lost their basic industry and now serve only as dormitories for workers travelling long distances to strictly temporary war factories. The fourth is the probability of a considerable volume of unemployability in certain areas. A full examination of this problem must be an essential part of any social security scheme which the Government may introduce.

The second part of the report discusses the work of the Council from June 30, 1942 to December 17, 1943. In its survey of industry the report, after

* Office of the Minister of Reconstruction. Welsh Reconstruction Advisory Council. First Interim Report. Pp. 132. (London: H.M. Stationery Office, 1944.) 2*s*. net.

stressing the necessity of securing an early expansion of the export trade in Welsh coal and recommending early steps to remove inequalities such as royalties and wayleave rents, urges that the Government should support mechanical firing as an alternative to oil for tramp and liner tonnage, and that the Board of Admiralty should consider its adoption, where practicable, in naval tonnage. Wales, however, may need an integrated coal-oil-power-and-chemical industry, developed as a whole, the keys to which lie in an abundant supply of cheap electricity and an extensive programme of research. Reviewing production of oil from coal, the Council recommends an early re-examination of the Fischer-Tropsch process in the light of changed circumstances, and the establishment of a trial plant in Wales after the War. It also seems desirable that further experience of low-temperature carbonization should be gained in Wales by allowing the plant already erected there to come into operation at the earliest possible moment after the War, while it is for consideration whether the whole question of the production of oil from coal is not one which cannot be dealt with satisfactorily within the structure of private enterprise.

In regard to the slate industry, the Council recommends immediate consideration of its place in relation to the post-war building programme, while attention is also directed to the particularly useful part which the refugee firms set up in Wales could play in the rehabilitation of the devastated countries of Europe. An adequate expansion of the tourist and holiday industry in Wales is conditional upon an improvement in communications to break down its relative inaccessibility, and the highest importance is attached to the provision of a trunk road from north to south Wales, passing through the beautiful but isolated centre of Wales, and to the early provision of a road crossing over the River Severn. The provision of better road communications across the Severn below Gloucester should be announced as part of the Government's reconstruction programme, the various schemes which have been put forward to be reviewed immediately by technical experts, and all road improvements on each side of the Severn should be related to the new means of communication. Establishment of at least one trans-Atlantic aerial terminus in Wales, suitably linked with the major road and railway routes, is also recommended.

The development of the tourist industry is recognized as demanding more study, research and planning than the Council has yet been able to give to it, and after endorsing the recommendations of the Scott Committee on this matter, the Council urges that at least one area in North Wales and one in South Wales should be developed as national parks at the earliest suitable moment after the War, with assistance from public funds if necessary.

The Council further emphasizes that Wales needs to explore very fully the potentialities of a marriage between industry and agriculture. Agriculture, the producers' goods industries, the consumers' goods industries and the tourist industry are all interdependent, and the expansion of each in Wales could, properly organized and co-ordinated, benefit all. General measures are also required to increase the industrial attractiveness of Wales—the provision of buildings of standard design, in advance of demand, on selected suitable sites, widely distributed, and the clearing and levelling of every site which, in the opinion of the regional planning authority, it is desirable to use for industrial purposes, are two suggested measures—while the provision of electric power at an exceptionally low cost is a fundamental requirement for many industries. Here the Council inclines to the establishment of a special Welsh electrical development board. Refitting of dairy farms is one of the most urgent of Welsh post-war agricultural problems, while in many areas there is room for substantial improvement in the general level of cleanliness and hygiene in milk distribution. In regard to grassland and ley farming, a comprehensive examination of the whole position in the light of long-term requirements, and in terms of the quantities of equipment and fertilizers that would be required, as well as of the problems of finance and land ownership that would be raised is desirable. The importance of a long-term policy of afforestation is also stressed, as well as the suitability of Wales for timber-growing; special study of the types of trees best suited for planting in different parts of Wales is recommended. Stress is also laid on the improvement of facilities for technical education, in which co-operation between industrialists and educational authorities and between the local authorities themselves is essential. In this respect the Council, commenting on the White Paper on Education, regards it as unfortunate that rearrangements should be made within the present structure for one service without reference to the general problem of the reorganization of local government as a whole.

# THE FATIGUE OF GLASS UNDER STRESS

By E. OROWAN

Cavendish Laboratory, Cambridge

GLASS under stress shows a characteristic fatigue phenomenon of practical importance: it can be broken by stresses far below its ordinary breaking stress as measured in short-time tests, provided that the load is applied for a sufficiently long time. About one third of the short-time breaking stress is sufficient to produce fracture if it is sustained for a number of weeks. In contrast to metals, the stress need not fluctuate periodically in order to develop this fatigue phenomenon, of which the most spectacular everyday manifestation is the sudden spontaneous cracking of glasses or bottles under internal stresses which they may have withstood for many years.

As with metals, the practically important question is whether a 'safe stress' exists; that is to say, whether there is a stress limit below which the glass can stand up to the load indefinitely. Extensive experimental work has been carried out on the dependence of the time of breaking upon the breaking stress, and the latest investigations[1,2] seem to lead to a relationship between these quantities that can be represented approximately by a straight line if both stress and time are plotted logarithmically. If extrapolation to longer times is justified, this would mean that no safe stress exists, and, therefore, glass would be an essentially unreliable material for use under sustained loads.

In a recent issue of *Nature*[3], J. B. Murgatroyd has discussed this phenomenon. In his view, the influence of the duration of loading is "not easily explicable by Griffith's theory alone", and he suggests an explanation based on the assumption that glass consists of "an elastic matrix which contains small pockets of

'quasi-viscous' material". This model is then worked out mathematically, and a certain agreement is found with the measurements just mentioned; unfortunately, however, the basic equation used to express the strain in the viscous elements is incorrect, and this has the effect of invalidating the conclusions. The relationship between stress $S_v$, strain $\sigma$, time $t$, and coefficient of viscosity $\eta$ for a viscous rod under tension is $S_v = 3\ \eta\ \frac{d\sigma}{dt}$, not $S_v = \eta\sigma/t$. The correct mathematical treatment of Murgatroyd's model leads to the existence of a maximum and a minimum value for the strength, reached asymptotically for very short and very long breaking times, instead of the straight line in his Fig. 2. In order to explain, for example, a ratio 3·3 between short-time strength and long-time strength, it would be necessary to assume that in any cross-section only 30 per cent of the area corresponds to the elastic matrix which alone is capable of taking up a sustained stress, and 70 per cent to the material of the viscous pockets, which on this hypothesis would constitute the greater part of glass.

My purpose here is to show that the decrease of the breaking stress with increasing duration of loading can be explained on the basis of the Griffith theory without *ad hoc* assumptions, and that in this way the ratio of the breaking stresses for very short and very long duration of loading can be calculated, in reasonable agreement with experiments. It will be seen that, in the absence of other causes of fatigue, this explanation demands the existence of a safe stress roughly equal to a third of the short-time strength. It suggests that, on extending the duration of loading beyond the range so far investigated, the logarithmic strength – time curve would bend away from the inclined straight line and go over asymptotically into a horizontal line, corresponding to constant strength for very long times of breaking.

Griffith's expression for the tensile strength $k$ of a brittle isotropic solid is

$$k = \sqrt{\frac{2\ \alpha\ E}{\pi c}},$$

where $E$ is Young's modulus, $c$ the depth of the most dangerous surface crack, and $\alpha$ the surface energy. Now it has been found by Obreimow[4] that the surface energy of mica, if measured by cleaving in vacuum, is about ten times higher than in air. According to measurements I have made[5], the surface energy of mica is 4,500 erg/cm.$^2$ in vacuum and 375 erg/cm.$^2$ in air. Owing to the chemical similarity between mica and glass, a similar ratio may be expected for the latter. If the adsorbed film of air or moisture that is responsible for the reduced value of the surface energy in air can penetrate to the bottom of the crack, this value must be used in the Griffith formula when the material is broken in air, and the higher vacuum value when the tensile test is performed in vacuum. According to the Griffith formula, the tensile strength is then about $\sqrt{4500/375} = 3{\cdot}5$ times higher in vacuum than in air[6]. In fact, Schurkow[7] has found that the strength of silica glass fibres, baked out and broken in vacuum, is 3·5–4·5 times higher than in air.

If fracture occurs after a very short time, the adsorbed film cannot follow the propagation of the crack from the surface zone into the interior; the cleavage surfaces created by the crack propagation will then be clean, and the stress necessary to produce such rapid fracture is obtained from the Griffith formula by using the vacuum value of the surface energy. If, on the other hand, the crack deepens very slowly, the adsorbed film has time to diffuse to the bottom of the crack and reduce the surface energy to the lower value corresponding to cleavage in air. The ratio of the breaking stresses for very rapid and very slow fracture, according to the Griffith formula, is then equal to the square root of the ratio of the surface energies in vacuum and in air, which is about 3·5 if it is permissible to use for glass the ratio obtained with mica. This agrees well with the results of Preston[3], who found that the breaking stress increased 3·2-fold as the breaking time was reduced from $10^5$ to $10^{-2}$ sec. Holland and Turner[1] investigated glass strips in bending; here the breaking stress for rapid loading was about 3·3 times higher than the stress under which all specimens broke within 1,000 hours.

It seems, therefore, that the rate of diffusion of adsorbed matter into the Griffith crack may account quantitatively for the influence of the duration of loading upon the breaking stress. If this explanation be correct, glass should have a safe stress limit below which it would stand loading indefinitely, and this safe limit should be reached in practice in the long-duration tests of Holland and Turner and of Preston. The question whether or not the straight-line relationship breaks down for extremely long breaking times calls for further investigation; this may prove very difficult because, during the test, surface corrosion and devitrification may occur, and their effect may mask the one to be studied.

If the fatigue effect is mainly due to the finite rate of diffusion of the adsorbed film in the crack, certain characteristic phenomena should be expected. First, short-time strength and long-time strength should be equal if the test is performed in vacuum on specimens baked out in vacuum, and they should further be equal to the limiting short-time strength in air. Secondly, specimens that have been subjected for a length of time to a stress exceeding the safe long-time strength, but released before fracture occurs, should show reduced strength in short-time tests, for the following reason. Under a stress that is lower than the short-time strength but higher than the safe stress, the most dangerous surface cracks are propagated slowly, at a rate that is determined by the rate of diffusion of the adsorbed matter. When they reach the depth at which, according to the Griffith formula, further propagation under the given load becomes possible with the vacuum value of the surface energy, sudden fracture occurs. If the loading is interrupted before this happens, the cracks will nevertheless be deepened, and the short-time strength of the specimen reduced.

If the adsorption – diffusion effect is the main cause of the fatigue, it should be possible to increase the resistance of glassy materials to long-sustained loads by covering the surface with a sufficiently inert and impermeable varnish, or by a glaze of which the coefficient of thermal expansion is lower than that of the bulk. For similar reasons, the decrease of the breaking stress with increasing duration of loading should be slower with toughened glass, in which the surface layer is under compressive stress; here the surface cracks are either altogether ineffective, or at least the diffusion of atmospheric matter into them is made slower by the compression of the cracks at the surface.

The viscosity of the glass cannot be expected to influence the strength except at temperatures where the viscous deformation is of noticeable magnitude.

Its influence, however, would be opposite to what is observed with glass at room temperature. Viscous deformation makes the bottom of the cracks less sharp, and thus raises the strength by reducing stress concentrations. An increase of the tensile strength with temperature in the region of incipient plasticity has, in fact, been observed on colophonium and colophonium - shellac mixtures by Hauser[8]. Prolonged action of stress, therefore, would make the specimen stronger, not weaker, so far as the viscosity effect alone is concerned.

[1] Holland, A. J., and Turner, W. E. S., *Trans. Soc. Glass Tech.*, 24, 46 (1940).
[2] Preston, F. W., *J. Appl. Phys.*, 13, 623 (1942).
[3] Murgatroyd, J. B., *Nature*, 154, 51 (1944).
[4] Obreimow, J. W., *Proc. Roy. Soc.*, A, 127, 290 (1930).
[5] Orowan, E., *Z. Phys.*, 82, 239 and 259 (1933). Obreimow's original figures for the surface energy contain a factor 4 due to an error in the expression for the moment of inertia of the cross-section of the mica lamella. The values given by me have been obtained from measurements with a somewhat improved technique.
[6] Orowan, E., *Z. Phys.*, 86, 195 (1933).
[7] Schurkow, S., *Phys. Z. Sowjetunion*, 1, 123 (1932).
[8] Hauser, F., *Verh. deut. phys. Ges.*, 14, 18 (1912).

# NATIONAL INSTITUTE OF ECONOMIC AND SOCIAL RESEARCH

THE annual report of the National Institute of Economic and Social Research for 1943 is of exceptional interest. In addition to a general report and a report on research in 1943, the report on the library and equipment and the usual list of publications and of research staff at December 31, 1943, it includes a discussion of the Institute's research policy, which is of considerable general interest in relation to the statement in the White Paper on Employment policy of the Government's intention to establish a permanent central staff qualified to measure and analyse economic trends and to call for more quantitative information from industry on current economic movements.

Originally it was anticipated that the proper field of the Institute's work would lie mainly in the measurement of changes, the discovery of trends and the analysis of structure, and its first inquiries were directed to the measurement of the national income in Great Britain, the economic problems of nutrition, the extent and distribution of unemployment and the location of industry. The systematic study of these subjects has now been taken over by Government departments with resources that no private agency could command, although the Institute has been able to supplement official studies by its own studies of the national income, consumption and other subjects.

The Institute's resources have also been fully occupied during the War on related inquiries, and the accelerated extension of realistic and statistical studies in the social sciences due to the War has led to the Institute being approached not only by Government departments and academic workers, but also by business men and their associations, with suggestions for research or requests for assistance in organizing research. Although the War has incidentally added largely to the small number of research workers experienced in realistic and statistical investigation, the need for such study will be as great for a time when hostilities cease as during the War, and the resources of the Institute are likely to be strained by the demands made on them. Even when an authoritarian direction of industry is removed, an exact and comprehensive, constantly adjusted analysis of resources and requirements will remain necessary as a basis both for Government policy and private business decisions.

Economists and other students of the social sciences will find themselves faced, therefore, with demands for guidance which will be unprecedented in scale if not in character. Even when the analysis is dictated by a theoretical approach, the post-war need will be the statement of problems in realistic and quantitative terms. For this, mechanical aids as well as the resources of specialized library and adequate secretarial staff will be essential, and such resources the Institute hopes to provide on a greater scale in future. Calling in the co-operation of experts in different fields, it can promote and arrange for the direction of inquiries and provide the personnel and material aids for their execution. It will endeavour to develop a part of the field itself, and will co-operate with individual students and other agencies working in the same or connected fields; but apart from a small portion of its funds held ready to meet requests for assistance from individual scholars, the bulk of the Institute's resources should be concentrated on one field where there is a prospect of achieving definite results without serious overlapping with the activities of the research departments of the universities.

The executive committee of the Institute has now reached the conclusion that this main effort should be directed to work on the structure and productivity of the national economy in Britain. In its simplest form the object is to examine the way in which wealth is created in Great Britain, to inquire what determines the amount of wealth created in the average man-hour of British labour, how it compares with other countries, what underlies the differences, what causes the gradual increase and what could be done to accelerate it. Two major projects now in train fit naturally into this framework. The statistical inquiry into the national expenditure, output, and income of the United Kingdom in the years between the Wars provides the essential basic data, and the co-operative inquiry into the distribution of the products of industry is an attempt to see how far existing data shed light on these questions. The Institute would also hope to supplement these inquiries with detailed factual inquiries into the experience of specific British industries, directed particularly to the relation of costs and efficiency and to comparisons with industries in other countries.

The general report refers to the circulation of the first issue of the Register of Research in the Social Sciences, which continues to be prepared by the secretary as editor, with the assistance of the editorial advisory committee appointed by the Consultative Conference on the Social Sciences. The Institute has continued to provide facilities for the activities of the National Service Committee for Social, Economic and Statistical Research, and this Committee is preparing a memorandum on the post-war position of the education and employment of economists at the request of Lord Hankey's Interdepartmental Committee on Further Training and Education.

Most of the research work during the year represented the continuation of programmes already in progress, but the Institute took under its wing the inquiries initiated by Mr. R. Titmuss into "Disease Mortality and its Changing Distribution in England

and Wales" and the statistical inquiry into "Methods of Investigating Oscillatory Movements in Time-series" by Mr. M. Kendall. Dr. A. Baykov's study on "The Development of the Soviet Economic System" was enlarged, and final work on its preparation for the press substantially completed. M. N. Momtchiloff's study of the financial and economic experience of south-eastern European countries was published early in 1944 under the title "Ten Years of Controlled Trade in South-Eastern Europe". The programme of work on local taxation studies undertaken by Prof. and Mrs. Hicks was modified, a study on wealth and poverty in local government being postponed in favour of two 'occasional papers', one of which, "Problems of Valuation for Rating", is in the press and the other, "The Incidence of Local Taxation in England and Wales", was awaiting comment by certain Government departments at the end of the year.

Besides the two major inquiries in progress already mentioned, that by Miss P. M. Deane on "The Measurement of National Income of Selected Colonial Territories" was also continued, but at the end of the year the inquiry into aspects of commercial policy was suspended. An investigation into the economic effects of advertising was started in the middle of the year, and M. N. Momtchiloff began work on a new inquiry into the monetary position of the six south-eastern States of Europe. In the spring, a grant was made to the University of Birmingham in support of Prof. Sargent Florence's inquiry, "Location and Optimum Size of Plants in Particular Industries", which is intended to test the hypothesis that there is an important relation between the size of an industry's plant and its location pattern.

Some further details of the research work of the Institute are given this year in a new Publications and Programmes pamphlet which, in addition to listing studies and occasional papers already published and publications now in the press, includes an account of some of the programmes of research on which those publications are based, and also of other publications in active preparation. Among these may be mentioned the study, "Personal Expenditure on Consumption in the United Kingdom, 1920–1938", and the occasional paper, "The Structure of Money Flow Systems", both coming from the major programme of research into national expenditure, output and income directed by Mr. R. Stone; two occasional papers, "Productivity, Prices and Distribution in Selected British Industries" and "International Comparisons of Productivity, Cost Ratios and Share of Wages in British, American and German Manufacturing Production" under the Distribution of the Product of Industry inquiry; and A. Collier's "The Crofter Problem: A Study of Economic and Social Conditions in the Highlands and Islands of Scotland".

## FORTHCOMING EVENTS

### Wednesday, September 13

BRITISH ASSOCIATION OF CHEMISTS (LONDON SECTION) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. H. W. Rowell: "The Development of Plastics".

## APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DIRECTOR OF THE BRITISH NON-FERROUS METALS RESEARCH ASSOCIATION—The Chairman of Council, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1 (marked 'Personal') (September 15).

ASSISTANT DAIRY BACTERIOLOGIST (temporary)—The Registrar, The University, Leeds (September 15).

SPEECH THERAPIST—The Director of Education, Education Offices, 15 John Street, Sunderland (September 15).

TEACHER (full-time) OF MATHEMATICS in the Nautical College Department of the Liverpool Technical College—The Director of Education, 14 Sir Thomas Street, Liverpool (September 15).

SPEECH THERAPIST (full-time)—The Director of Education, Hamilton Square, Birkenhead (September 15).

ASSISTANT (full-time) to teach either MECHANICAL ENGINEERING or ELECTRICAL ENGINEERING SUBJECTS in the Stockton-on-Tees Technical School and Evening Institute—The Director of Education, Shire Hall, Durham (September 16).

SENIOR SPEECH THERAPIST—The Director of Education, Education Offices, Nelson Square, Bolton, Lancs. (September 16).

LECTURER IN THE DEPARTMENT OF MECHANICAL ENGINEERING—The Registrar, Loughborough College, Loughborough (September 18).

UNIVERSITY READERSHIP IN CHEMISTRY tenable at the Royal Cancer Hospital (Free)—The Academic Registrar, University of London, South Kensington, London, S.W.7 (September 18).

POULTRY PATHOLOGIST for the New Zealand Department of Agriculture—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (September 18).

SPEECH THERAPIST (full-time)—The Director of Education, Education Offices, Wolverhampton (September 18).

ASSISTANT LECTURER IN MATHEMATICS—The Secretary and Registrar, The University, Bristol (September 20).

BOROUGH ENGINEER AND SURVEYOR—The Town Clerk, Town Hall, Walworth Road, London, S.E.17 (endorsed 'Borough Engineer and Surveyor') (September 22).

ASSISTANT REGISTRAR—The Registrar, The University, Sheffield 10 (September 23).

LECTURER (full-time) IN MECHANICAL ENGINEERING—The Principal, Battersea Polytechnic, Battersea, London, S.W.11 (September 23).

LECTURER IN VERTEBRATE ZOOLOGY—The Secretary, The University, Edinburgh (September 25).

LECTURERS (2) IN MECHANICAL ENGINEERING, and a LECTURER IN ELECTRICAL ENGINEERING—The Principal, West Ham Municipal College, Romford Road, Stratford, London, E.15 (September 25).

PHYSICIST (must have first-class experience on problems relating to Lighting and Aircraft and Automobile Lamps) for a Company in Birmingham—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. A.630.XA) (September 26).

CHAIR OF ELECTRICAL ENGINEERING—The Acting Registrar, The University, Leeds 2 (September 30).

CHAIR OF BIOLOGY in Victoria University College, Wellington, New Zealand—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (September 30).

PRINCIPAL OF THE HACKNEY TECHNICAL INSTITUTE, and PRINCIPAL OF THE SOUTH-EAST LONDON TECHNICAL INSTITUTE—The Education Officer (T.1), County Hall, Westminster Bridge, London, S.E.1 (September 30).

PRINCIPAL OF THE WALKER TECHNICAL COLLEGE, Oakengates—The Secretary for Education, County Buildings, Shrewsbury, Shropshire (September 30).

PROFESSOR OF PHYSICS—The Registrar, University College, Singleton Park, Swansea (October 18).

HONOURS GRADUATE IN CHEMISTRY (London, Reference No. F.2719.XA), HONOURS GRADUATES (2) IN METALLURGY (Neath, Reference No. F.2720.XA; Shipley, Reference No. F.2721.XA), and HONOURS GRADUATE IN CHEMISTRY or Member of the Royal Institute of Chemistry, Branch E (London, Reference No. F.2722.XA), on the research staff of a progressive National Organization with home and overseas interests—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting the appropriate Reference No.) (October 21).

LIBRARIAN—The Librarian, Queen's University, Belfast (October 31).

CHAIR OF PSYCHOLOGY in the University of Sydney—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (October 31).

BEYER CHAIR OF ENGINEERING—The Registrar, The University, Manchester 13 (November 18).

AGRICULTURAL SCIENTIST with intimate knowledge of livestock and breeding problems in this country, to take charge of the Board's Livestock Improvement Department—Milk Marketing Board, Livestock Improvement Department, Thames Ditton, Surrey.

CHIEF INSPECTOR (must have had first-class experience in Inspection of Steel and Non-Ferrous Products, and have full knowledge of A.I.D. procedure) by large Steel Foundry in Yorkshire—The Ministry of Labour and National Service, Appointments Office, The White Building, Fitzalan Square, Sheffield 1 (quoting Reference No. 107).

REFRIGERATING ENGINEER for West Africa—The Secretary, Overseas Manpower Committee, Ministry of Labour and National Service, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. 1162).

HEAD OF THE ENGINEERING DEPARTMENT—The Principal, Technical Institute and Secondary School, Dursley, Glos.

GRADUATE (temporary, man or woman) IN SCIENCE AND MATHEMATICS in the Pontypridd Junior Technical Schools (Building)—The Director of Education, County Hall, Cardiff.

## REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

Proceedings of the United States National Museum. Vol. 94, No. 3176: Twelve New Species of Chinese Leaf-Katydids of the Genus Xiphidiopsis. By Ernest R. Tinkham. Pp. 505–528. Vol. 95, No. 3178: New American Cynipids from Galls. By Lewis H. Weld. Pp. 24. (Washington, D.C.: Government Printing Office.) [38

Smithsonian Institution. War Background Studies, No. 19: The Peoples of French Indochina. By Olov R. T. Janse. (Publication 3768.) Pp. iv+28+25 plates. (Washington, D.C.: Government Printing Office.) [38

# NATURE

No. 3907 SATURDAY, SEPTEMBER 16, 1944 Vol. 154

CONTENTS



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New Delhi

## SCIENTIFIC AND INDUSTRIAL RESEARCH.—IV

WE have now considered the questions which arise in regard to personnel, whether of its quality or of the tactics by which the best use can be made of the men and women trained for scientific and industrial research. We have seen that some regard must be paid to our needs, not only in respect of quality but also of the numbers of such workers. Any serious discrepancy between the output of such trained men and women from the universities and technical colleges and the demand of the nation for their services must have serious consequences, either by impeding the immediate execution of our research programmes, for example, or by discouraging men and women of the highest ability from entering on such careers.

No attempt can be made to estimate our quantitative requirements in regard to research workers and other classes of scientific workers without some consideration of the actual programmes of research at which they will be required to work or of the openings for their services in other fields. This, accordingly, is the next step to be taken in approaching the consideration of the actual organization to be set up for the planning and execution of our research programme. If, as the Nuffield College statement suggests, the vital question at present is how much Great Britain must spend at once on scientific and industrial research in order to reap the fullest possible advantage of her resources of man-power and productive capacity, the answer can only be given after consideration of specific needs and projects, and as a result of the elaboration of concrete plans of development in a great number of particular fields. Moreover, it is only as such specific plans take shape that we can see at what points development is uneven, what gaps require filling and what weaknesses should be strengthened.

The Nuffield College statement is not concerned with such specific plans, and largely excludes from its survey the needs of agriculture, health and other fields which make a special call on trained biologists. None the less its paragraph on the claims of biological science is clear warning that there must be some consideration of the relations of the particular programmes and the demands they involve in order that our available resources may be distributed to the best advantage, and our research effort not badly thrown out of balance. It may well be doubted whether hitherto biological studies have attracted anything like a high enough proportion of the best scientific minds, and if that is so, the position is one that can only be remedied over a period of years. Advances in the biological sciences are fundamental for progress in agriculture, horticulture, forestry, food preservation, fisheries, conservation of water supplies, health education, and for the solution of other pressing world problems. They are vital for the future of tropical countries, for the mastery of soil erosion and for the repair of much of the devastation wrought by man upon his environment during the years of wasteful exploitation of natural resources.

It was suggested by the Parliamentary and Scientific Committee in its report on "Scientific Research and the Universities" that the future impact of biological advances in agriculture, medicine, nutrition and sociology may be of the same order of importance as that of physics and chemistry in the past fifty years. The demand for biologists in the post-war world is bound to be very large, and Great Britain is not well equipped to supply it. Moreover, the Nuffield College statement further points out, the experience of the War has shown that the trained biologist is a highly adaptable person, capable of making most valuable contributions to the solutions of problems quite outside his special field of study. That has a bearing on the position of biological science in the content of our general plan of education, and there are other considerations which should induce us to give general biology a higher place in the curriculum. At least it can be said that the place of biology in reconstruction demands a special survey, with an expansion of research and the formation of further chairs at the universities in such related subjects as genetics, ecology, biochemistry, and veterinary science.

Closely related is the question of social biology. The contribution which biology might make to the ordering of a new world, not merely as a corrective to mechanized planning but also as a guide to a true way of life, to the establishment both of greater control over our environment and over ourselves has been well emphasized by Sir Walter Langdon-Brown (*Nature*, 152, 166; 1943) as well as by Dr. K. E. Barlow in "The Discipline of Peace". That contribution may be as vital to the wise use of our natural resources as to the development of the appropriate organization of our affairs, both in regard to the conduct of scientific and industrial research, and the better ordering of international relations. Discussions such as those proceeding on world security at Dumbarton Oaks need to be examined, and their proposals require objective criticism by those trained in the scientific method so that disciplined and well-informed judgments based on values and not on extravagant and prejudiced opinion are reached.

Here we touch on a further field where our research effort in the past has been inadequate and where our technique is yet only being developed, because the limitations of the scientific method in situations involving judgments of value have not always been fully recognized. In his admirable little survey of the British universities in 1930, Sir Charles Grant Robertson urged that the advancement of knowledge could not without grave danger be limited to research in the physical sciences. In a revised edition of that book, which has just appeared, his argument is reinforced by all the experience of the past fifteen years, and he affirms his conviction that the only knowledge worth advancing is 'related knowledge'—knowledge of which the affiliations to, and contacts with, all other forms of knowledge are recognized and the total sum of which is purposively related to the ends of a civilized society seeking to fulfil a spiritual interpretation of life.

Sir Charles Robertson's plea is essentially that the universities can make themselves the central arsenals of a true humanism, but this question of social and economic research goes further and has a close bearing on many of the material problems with which we are confronted. The Nuffield College statement, in a passing glance at research in relation to social and economic policy, indicates how fruitful such research could be even from the point of view of securing more effective use of the results achieved by advances in industrial research in the physical field. Indeed the determination of the best form of structure, both government and non-government, for bringing about a co-ordinated study of economic and technical problems so that the machinery devised for shaping general economic policy will effectively relate the needs of consumers to the real potentialities of the productive system, in respect of type of product, quality and price, in the light of impartial scientific evidence drawn from both fields of research, is pre-eminently a matter for the consideration of Nuffield College.

The whole trend of the recent report "Government and Industry: A Framework for the Future" issued by a Fabian research group encourages the hope of a more impartial and objective approach to such problems. The importance of this field and the wide scope for impartial inquiry it offers can well be seen in the annual report of the National Institute of Economic and Social Research and especially in the recently published account of its publications and programmes. The need for a more equable distribution of our research effort between the social and biological and the physical sciences, whether at the fundamental level in the universities or in the attack on the practical problems of production and administration, is well illustrated in an article on the "War-time Social Survey" contributed by its director, Mr. Louis Moss, to *Public Administration* of October-December 1943. Mr. Moss pointed out that social research assists the administrator by enabling him to take the major relevant social facts into consideration in framing his policy, to measure the extent to which his policy has been successful after it has been put into operation, and to decide what changes, if any, are necessary to ensure its success; he also indicates five main spheres in which the Social Survey could be of assistance to Government departments in the post-war period.

The significance of the Social Survey's studies of food and clothing habits, and particularly the improvement of sampling methods, and the bearing of such studies on cost-of-living indexes and inquiries are obvious. Similarly, the work already done in checking the effectiveness of the educational publicity of the Ministry of Health and in exploring resistance to such schemes as child immunization against diphtheria is a promising aid to prophylactic measures which could raise the general standard of health. The value of the techniques by which the Survey has during the War rapidly secured a fairly good picture of the nutritional situation of the nation as a whole, or of particular groups, is also clear. Social research can also make an effective contribution to the removal of obstacles to a complete productive effort and thus assist in the full use of our skilled

man-power which is likely to be no less important after, than during, the War, and finally it should equally assist in eliminating many of the errors in housing and building policy which have arisen through imperfect contact of the administrator and expert with public needs.

This function of social research is, of course, essentially the elaboration of an effective liaison system, thus enhancing the adaptability of our social and industrial organization—the vital problem in elaborating an effective organization, as Dr. J. T. MacCurdy insists. Without going into further detail, it should be emphasized that not only are research workers required in these broad fields of biology and economics and social science but until, in some degree, the programmes of research are formulated, we cannot forecast approximately the numbers of workers in these fields which the universities are expected to provide. Furthermore, as is brought out to some extent in the statement "A Post-War Policy for Science", issued by the Association of Scientific Workers, these programmes themselves at times impinge on programmes for the development of natural resources and may determine their expansion or contraction. Nor can we well consider the re-orientation of our research effort until the broad programmes of work proposed in the different fields are seen in sufficient detail for a true perspective to be obtained.

It must not be imagined, however, that it is only in the social and economic field that there are gaps in our research effort, or special reasons for expansion. Sir Ernest Simon, for example, has directed attention to the neglect of aeronautical engineering, and to the active intervention of the Ministry of Aircraft Production to found an effective school of aeronautical engineering research. Again it is only possible to assess the importance of such gaps when we obtain from the broad programmes a picture of the general position.

Some attempt has been made by the Association of Scientific Workers in the statement already mentioned to cover the ground, and a number of particular programmes has already been outlined, such as that of the British Coal Utilization Research Association, for a thorough scientific study of the fundamental properties of coal. Despite the stimulus of the proposals of the Hot Springs Conference no adequate programme of nutritional research or of agricultural research has yet been formulated. Some of the main specific topics in the latter field are indicated in the Association of Scientific Workers statement, while, as we have already seen, the former involves not merely biological research but also the co-operation of workers in social science.

Closely related to this last is the field of medical research, and it may well be expected that one consequence of a national service for health will be a fresh impetus to research on the elimination of conditions responsible for sickness absenteeism, accidents, industrial disease and low standards of health or physique. The man-power situation is also likely to increase the importance of such work, as is the general age-structure of the population. Apart from this there is the stimulus that is derived from the striking advances in chemotherapy during recent years and from the realization of the immense resources which science has given us for preventing and eliminating disease apart altogether from its treatment. Besides this, as Dr. Alan Gregg has suggested, increasing attention to the geography of disease and, as a natural corollary, to the study of the relation of climate to disease and health, is called for. The effect of differences of environment on genetically similar organisms, biophysics, and the application of genetics to the study of human disease and human physiology, as well as both chemotherapeutic and pharmacological research, are likewise fields where he considers development is needed and probable.

In deliberately directing attention to fields where research has been comparatively neglected, or where at least exceptional expansion is required, it is not suggested that other fields of research, either industrial or fundamental, should not figure prominently in our post-war programme. From the point of view of the national economy the main problems in some branches of manufacturing industry, in transport, and in communications may well be, as the Association of Scientific Workers suggests, concerned chiefly with effective planning and co-ordination in a policy of full employment and social welfare. In other branches of industry, progress is dependent on fundamental research on such questions as the mechanical and magnetic properties of metals, their corrosion and lubrication, the molecular physics and mechanics of rubber and plastics, including the various synthetic fibres, while the position of petroleum as a raw material is shifting the whole outlook of organic chemical industry, raising important economic as well as technical problems. Nor can our survey of programmes be limited to our own internal needs: we are already committed to large and to growing programmes of Colonial research, including industrial, agricultural, geological, fisheries, animal health, forestry and medical and social research, and topographical and geodetic surveys.

As we have already emphasized, if proper use is to be made of our available resources, both of man-power and materials, it is imperative that at an early stage there should be some overall view of the main objectives, as distinct from detailed or particular subjects in all the main fields of industrial and the chief branches of pure and applied science. Only so can be put together some rough estimate or global figure in terms either of men or financial or material cost. Until that has been done we are neither in a position to make the intelligent allocation of priorities of grants, of men and of materials, which in the early post-war years will be essential, or to see at what points there are gaps likely to delay progress, or obstacles to the prosecution of fundamental research for advancing the boundaries of knowledge on a broad front on which the ultimate success of any programme of research depends.

There can be no disguising the tremendous demands which this task of reviewing or co-ordinating the programmes of research in so many different fields will make. Scepticism as to the adequacy for such a

purpose of particular proposals as that of the London Chamber of Commerce in one of its recent reports should not induce a *non possumus* attitude. On the contrary, experience of what has in effect been achieved in the prosecution of the war effort should inspire a new attempt to improve on that organization, to adapt it where necessary, and, profiting by the mistakes of the past, to seek to deal with the research problems of the peace on lines retaining sufficient flexibility to avoid constricting the spirit of free inquiry, while ensuring that problems which are most urgent from the point of view of the public interest receive priority of effort and supplies; and that there is no neglect of important fields or problems vitally affecting public welfare, or the advance of either industry or of science because they are not sufficiently the concern of any particular body.

Finally, it must be remembered that from the point of view of scientific workers themselves some attempt to sum up the requirements of research from a national point of view and to indicate the broad fields to be intensively developed is equally important. First, it provides the universities with a rough basis on which to estimate the numbers of trained workers required both in total and in different branches of knowledge. Demands for workers in the natural sciences can be balanced with those for workers in the growing body of statistical, economic, sociological and psychological studies of no less importance to the community and to industry. But beyond this, it brings to research workers in any field a growing awareness of the relations of their problems to those of students in other fields. That consciousness, with the more intimate contact with research workers who are asking other questions and employing other methods, which should flow from the new and fuller integration of our research effort, should help to break down the isolation with which scientific workers have sometimes surrounded themselves in the past, and it should impart not merely a quickening sense of social or public service but also that fertilizing cross-current of ideas which always lies at the roots of creative thought and intellectual advance.

## A SURVEY OF THE U.S.S.R.

The U.S.S.R.

An Economic and Social Survey. By Dr. S. P. Turin. Pp. xiii+220. (London: Methuen and Co., Ltd., 1944.) 16*s*. net.

ENGLISH readers often find it difficult to obtain trustworthy information about the U.S.S.R. They suspect anything that looks like propaganda and much prefer a cold and clear-cut account that aims only at presenting the facts without bias one way or the other. For this reason much that has been written has lacked permanent value, and has probably had far less influence than its authors had hoped. On the other hand, the official statistics, which are good, are not easily accessible to the ordinary reader.

Dr. Turin's survey has the special value that it is based on official statistics, elucidated often by diagrams and presented objectively. He begins with an account of the geography and ethnography of the U.S.S.R.; then he discusses its regional structure, with which many readers will be unfamiliar. The centralization of production in the hands of the State has meant the welding of great areas into huge industrial units. The Moscow industrial region, or *oblast*, for example, has a radius of about 100–120 miles with Moscow as its centre, but every town, every village and every hamlet within it forms part of one big industrial concern. The importance of this particular *oblast* is that although it represents only about 1 per cent of the U.S.S.R. territory, it contains about 10 per cent of the total population and more than 25 per cent of the total industrial population.

Next follows an account of the industries themselves, beginning with agriculture. Before the Revolution, about 75 per cent of the population were engaged in agriculture; the 1939 census, however, showed only about 50 per cent so occupied. The figures are not quite clear, however, because in the summary table the workers on the State farms are apparently grouped with town workers, while those on the collective farms are given separately. The change from the older inefficient peasant system to more modern methods, and the great development of mechanization, enabled men to be released from the farms for the staffing of the new factories without any loss of food-producing power; there has, on the contrary, been a gain. The products, however, still remain in the same order of importance as before: grain still has the first place and livestock represents only about one quarter of the value of the output: relatively less than in 1913 and not much more in actual value.

The author recognizes the profound change in character of the collective farms since their inception, although the name has been retained throughout, and in an appendix he gives a clear translation of the rules set up by the central authority in 1935 and still valid. Of the cereals, wheat is the most important, and its output, which fell for many years after the Revolution, has risen since the second Five Year Plan began in 1933. The author does not, however, mention that in that year a new method of estimating yield of cereals was introduced which gives higher values than the old method; it is almost certainly a better method and its results are more likely to be trustworthy, but the change makes comparisons difficult. It is stated on p. 109 that the yields used to be over-estimated; but the evidence appears to point the other way. Rye comes next in importance, but its output has not expanded since 1913 although the population has grown. Oats have the third place, and these have increased to about the same extent as wheat, a result of the increased output of livestock products. The tables would have given a more faithful picture of the cereal position had they been continued beyond 1937. That was a magnificent season for cereals, and the yields in many places exceeded all records. As the author points out, 1930 was also an exceptionally good year for wheat, and the output jumped up to 35 per cent above its general level for the two years before and after: in 1937 the jump was even greater. I myself saw both these crops, and there was no doubt about their exceptional character.

Other branches of agriculture, especially technical, market garden and fodder crops, have developed

rather more than cereal growing, as usual when agriculture is being improved. The quantity of milk supplied to markets was in 1938 some $5\frac{1}{2}$ million tons, while in pre-Revolution days it had been only just over one million tons; the butter supplied to markets was formerly 120,000 tons per annum; in 1937 it rose to 185,000 tons. Meat production has also increased, and a packing industry has developed, this being the most convenient way of distributing the meat: nearly one thousand million cans are turned out annually, this being nearly six per head of population.

The timber industry has made less progress than agriculture, probably because of its inherent difficulties. There are in the U.S.S.R. (according to the "Great Soviet Encyclopædia") some 956 million hectares of forest, or 43 per cent of the total area, but much of this is in Siberia and transport of the timber is mostly by rail. Owing to clearances, increasing distances have to be covered: in 1933 the average distance of transport was 688 km., by 1937 it had become 1,055 km., and only 23 per cent of the timber could be transported by water. Added to these difficulties was what the author calls "the mistake of invading the industry with conscript labour, recruited from non-proletarian elements"—this, he says, has now been realized by the management of the industry as ill-advised.

The author has little to say about the industrial progress. An interesting chart on p. 122 compares the values of output from agriculture, industry and home industries in 1913 with those of later years, and shows the great fall by 1921 and the later recovery: by 1927 the values in millions of roubles were almost the same as in 1913. It is not stated whether the roubles had altered in value during that period, but the large prepónderance of agriculture is strikingly brought out. Unfortunately the chart ends there, and there is nothing to show whether agriculture has kept this great lead or not. Extensive data are given for outputs of the raw products of industry—oil, coal, ores and minerals—and there is an interesting account of gold-mining, which is still partly in private hands.

The book ends with some useful summary tables of imports and exports, some in tons and some in roubles, and a footnote directs attention to a change in the value of the rouble introduced on April 1, 1936, which is sometimes overlooked by writers and lecturers. Values prior to that date have to be multiplied by 4·38 in order to make them comparable with later values. The author does not say whether he has made this correction or whether it is left for the reader himself to do.

The book is so useful that a second edition may well be required. It would add greatly to its value if the author would give a little more explanatory information about the statistics and clearer indications of their sources. Two sets of official data are generally available in Great Britain relating to the U.S.S.R.: those in the official year-books and those in the reports presented to the party congresses, but they are not always strictly comparable one with the other. Periodically also other data appear in other official publications, but these again are not always comparable with the preceding, however good they may be in themselves. These differences in comparability are not always clearly indicated in the text, nor are the dates to which the figures refer always given. A striking chart on p. 104 shows the relative contributions of the individual farm products to the "total value of the whole yield of agricultural products". Grain and potatoes are grouped together; they would have been better separated: together they are said to represent 41 per cent of the total value of output. Live-stock account for 27 per cent but 'pasture' is listed separately at 16 per cent. 'Pasture', however, has no meaning apart from live-stock, and the reader is left wondering whether the 'pasture' has also been included in the 27 per cent for live-stock, in which case there is a certain amount of double counting, or whether its value has to be added to that of live-stock, in which case the total would come above that for grain and potatoes. But this cannot be right, as the official figure for the value of livestock products in 1937 was 25 per cent of the total output value. The text seems to indicate that the diagram refers to the collective farms: does it take account of the large number of live-stock owned by the peasants? (From the results of an inquiry reported in "Kolkhozy vo vtoroi Stalinskoi Piatiletke, 1940", it appears that the peasants in 1936 owned more animals than the collective farms.) It is not stated to what months the live-stock data refer, nor whether the figures for arable land include fallows intended for sowing but not yet sown. Fuller information would be particularly useful for the charts, which are otherwise very helpful. No dates are given for the population charts on pp. 11 and 13, though one apparently refers to an early census and the other to a later one.

It would be helpful also to give a little more information about the natural regions: English readers still think of European Russia, and the author indeed makes incidental references to it, but only indirectly can the reader estimate its size. It would be particularly helpful to agricultural students if the classification of the regions into tundra, marsh, forest, steppe, desert, etc., given only in a footnote on p. 4, could be expanded: that is the one used mostly in Great Britain. Finally, we should be grateful for a table showing the land utilization in the various regions of the U.S.S.R. The book is so good that one can safely anticipate it will have a long and useful life, and anything that will add to its value can be welcomed. E. J. Russell.

# A NEW DETERMINATIVE TABLE FOR ORGANIC COMPOUNDS

**The Optical Properties of Organic Compounds**
By Alexander N. Winchell. Pp. xiii+342. (Madison, Wis.: University of Wisconsin Press, 1943.) 5 dollars.

The value of the polarizing microscope in identifying and characterizing minerals is well known, but its application to organic crystals is not yet by any means general. The customary description of a new compound includes a precise statement of its melting point, boiling point and other physical properties; but when it comes to crystalline form the description all too frequently lapses into the vagueness of white needles, orange prisms or colourless plates. A more careful description of superficial appearance is perhaps considered unnecessary because crystal habit is notoriously dependent upon environment during growth, and may vary from one preparation to another. If reasonably well developed crystal specimens are available, resort to the goniometer will provide data which are definitely char-

acteristic of the compound. Very often, however, such well-developed specimens can only be obtained with considerable difficulty, and the material is more usually in the form of minute, even microscopic crystals or fragments of crystals. It is perhaps not generally realized that on such unpromising material the polarizing microscope can provide accurate measurements, not of one but usually of several distinct physical constants which, taken together, provide an exceedingly reliable means of characterizing the compound.

The optical properties most useful for this purpose are the refractive indexes, usually three in number for compounds of low symmetry. The aim of the work before us has been to collect the crystallographic and optical properties of all organic compounds of which the indexes of refraction have been measured, up to and including the year 1940. The description of each compound gives name, formula, crystal data, including habit and cleavage, with requent diagrams (no structural data are given, only axial ratios), density, melting point and a full and careful description of the optical constants. One difficulty which must be faced by the compiler of any work of this kind is in dealing with imperfectly determined data, as arises, for example, when crystals are studied in one position only (usually on the largest face, or cleavage surface). Indexes of refraction thus determined are not necessarily the true principal indexes, and in the present work all such cases have been carefully distinguished by listing such indexes as $N_1$ and $N_2$ to distinguish them from the true values of the principal indexes, $N_g$ and $N_p$. Such careful and critical treatment of the data by one who is a recognized authority on the subject gives a high value to the present work.

The arrangement of the systematic section, which includes more than a thousand organic compounds, follows that of the fourth edition of Beilstein's "Handbuch der Organischen Chemie", with slight modifications to bring certain isomorphous salts together. This is followed by a determinative table, occupying about seventy pages, in which substances are arranged in order of increasing index of refraction (the index for the ordinary ray, $N_o$, or the intermediate ('mean') index, $N_m$, is used for anisotropic substances and the other indexes are also given). This information is then summarized in a very useful diagram on which all the compounds are plotted, refringence ($N$, $N_o$ or $N_m$) along one axis, and positive or negative birefringence along the other. By means of this diagram and its key, any of the compounds listed can be very quickly identified solely by its refractive indexes.

The appearance of this work brings to mind two other systems, already in progress, which aim at the identification of a substance by means of its crystalline properties. In the Barker Index at Oxford, substances are classified according to their characteristic interfacial angles, and rules are provided to ensure that no ambiguity shall arise in the choice of the classification angles. It is understood that considerable progress has been made in the compilation of this index, and trials have shown that positive identifications can be made with considerable speed[1].

Finally, there is the Index of X-ray Diffraction Data prepared by the American Society for Testing Materials[2,3], which aims at rapidly identifying any substance that will give a powder photograph. This method is undoubtedly the most universal in its application, as visible single crystals of the material are unnecessary. But X-ray apparatus, however, is still a rarity in many chemical laboratories.

These various methods for the rapid identification of substances will undoubtedly become of increasing importance in the future, as the necessary data are accumulated and become classified. The factor which severely limits the usefulness of all these methods at present is the comparatively small amount of accurately ascertained data in comparison with the vast number of known chemical substances. Further progress on any of these projects will call for carefully planned co-operative work on a very large scale. Some kind of conference is needed to decide on the best methods and to organize the work.

Even if the average chemical laboratory does not possess a goniometer or an X-ray apparatus, it should at least have a good polarizing microscope, for optical measurements on crystals have an importance far exceeding the rather utilitarian aspect of mere identification. In elucidating unknown structures, for example, they played a great part in Bernal's early work on the sterols[4]. In the main day-to-day work of the chemical laboratory the microscope, if competently used, can effect a great saving of time and labour[5]. Winchell's book should therefore make a wide appeal to those who have become familiar with the uses of this valuable instrument. J. MONTEATH ROBERTSON.


[1] *Nature*, **144**, 298 (1939).
[2] *Nature*, **149**, 437 (1942).
[3] *Nature*, **150**, 738 (1942).
[4] Bernal, J. D., Crowfoot, D., and Fankuchen, I., *Phil. Trans. Roy. Soc.*, A, **239**, 135 (1940).
[5] See, for example, Chapter 7 of "Crystals and the Polarising Microscope" by N. H. Hartshorne and A. Stuart (Arnold and Co., 1934).


# BACKGROUND OF ART AND SCIENCE

## Art and Scientific Thought

Historical Studies towards a Modern Revision of their Antagonism. By Martin Johnson. Pp. viii+192+16 plates. (London: Faber and Faber, Ltd., 1944.) 16*s*. net.

IT is impossible to mix with people these days without continuously meeting the question of values. "Why do we do this, and why do we do that?" Not so much *how* as *why*. Otherwise expressed, there is a tendency to show less interest in systems of law than in ends to be attained, an outlook essentially teleological in character. Historians, including those of the arts, will breathe freely in such an atmosphere, and scientific men (or at least some of them) would experience a certain awareness that experimental knowledge cannot indefinitely rid itself of responsibility for its discoveries, for good or for ill. Dispositions something like these have clearly been at work in Dr. Martin Johnson's mind, and the remarkable book before us is the result.

To begin at the beginning, Mr. Walter de la Mare writes as charming a foreword as only he can do. Discussing poetry, he says that "Mere endeavour will neither achieve its creation nor win the secret of its power and beauty". But immediately before this he remarks that "poetry . . . is essentially different" [from science]. The implication is perhaps scarcely happy. The supreme accomplishments of science are —of their kind—pure art, and those responsible for

them are, like poets, born not made. It is true, of course, that works of art endure, whereas even the best of scientific theories do not. The latter are for ever yielding place to less imperfect successors. But for all that, "power and beauty" are shared by art and science alike, in mutual reverence.

Dr. Martin Johnson himself starts with a series of essays, dealing with those features of the arts and sciences which show marked resemblances and contrasts. He traces the function of pattern, structure and form, and finds that, without metaphysical complications, the paramount need is for communication. To a work of art there is obviously an infinity of emotional patterns registered by different observers, whereas all mental judgments of a scientific theory tend necessarily to identity.

We are next presented with a number of examples of imaginative stimulus. Perhaps these are the most revealing pages of the book, and indeed they are entrancing. Beethoven's last years, and his music, are pictured with sensibility and yet with restraint. In a few sentences the author casts upon this scene of distress what Whitehead meant when he defined religion as "what the individual does with his own solitariness". It is all too likely that the great musician could but point others to the skies, chained and bound to earth as he was himself.

From such quests of the imaginative, Dr. Martin Johnson turns squarely to apply the historical method in his descriptions of Persian, Arab, Greek, Moslem and Chinese investigations relative to mathematics and the design of scientific instruments. It is well done, if a trifle heavy compared with the rest. These chapters end with an able discussion of symbolism and its place in some future conciliation between science, religion and art. Of course, this theme has been attempted before. One has only to recollect such diverse names as Otto, Streeter, Collingwood, to realize how 'pontifical' (in the correct sense of the word) an approach this is. Seldom can synthesis have been more effective.

The last five chapters are devoted to Leonardo da Vinci. Considering the weight of scholarship which has already descended upon the elucidation of this remarkable personality, this new contribution is fresh in outlook and distinguished in presentation. Leonardo had no love for pure mathematics, and even less for metaphysics. His experimental genius derives fundamentally from Archimedes, for whose works, by the way, he sought long and patiently, against enormous odds. There is little doubt that, consummate artist as he was, he became ever more and more engrossed in scientific work, which led him on to a type of extreme veneration for natural law.

In general, the historical point of view is suited to the aim of this volume; its constant use, however, tends to exclude completely certain modern aspects of the relations between the arts and sciences which are much to the point. Maybe the future will provide opportunities for ventilating them; in any event, such a background as we have here is a necessary pre-condition for their appreciation.

Incidentally, there are a few odd little mannerisms; readers' memories may be short, but it seems needless to repeat the dates of the Chou dynasty three times in six pages. The index is strangely capricious: sometimes proper names are entered, sometimes not, without any apparent reason. Occasionally the missing reference is much more interesting than the one which is listed.

Finally, this is certainly the moment to discern—and perhaps even the place to rejoice in—the author's abundant charity, which seeketh not her own [and] is not easily provoked. Dr. Martin Johnson has produced something of great price, and of engaging modesty; of that wisdom, in fact, which stoops to conquer. F. IAN G. RAWLINS.

# PHILOSOPHY AND PHYSICS

**Fact and Fiction in Modern Science**
By Henry V. Gill. Pp. vi+194. (Dublin: M. H. Gill and Son, Ltd., 1943.) 8*s*. 6*d*.

THIS book is substantially a reprint of essays which have appeared at different times in various journals. The author has the advantage of a more profound knowledge of philosophy than most popular writers on science, and his comments are more sober and orthodox than might perhaps be anticipated from the somewhat flamboyant title. The scope is sufficiently indicated by chapter-headings such as "The Nature of Scientific Knowledge", "From Physics to Philosophy", "Logic and Modern Science", and "Determinism, Uncertainty, and Free Will".

An interesting suggestion (p. 24) is that "the philosophy of Eddington would seem to approximate to that of the scholastics". To justify this affiliation, one may start from Eddington's affirmations that "all that physical science reveals to us in the external world is group-structure" and "Physical Knowledge is structural knowledge". But if we try to develop the Eddingtonian philosophy consistently beyond the point to which Eddington himself has carried it, we are led to inquire what (if anything) is this structure the structure *of*? What would, so to speak, be left behind if all structure could be imagined as annihilated? Clearly it cannot be ordinary matter, for ordinary matter even in its most elemental form as electrons, protons, etc., has qualities which must be included in the category of structure: the ultimate residuum which is wholly devoid of structure must be a limiting conception, a pure potentiality, something not capable of existing alone; and surely this is nothing other than the *materia prima* of the scholastics, Eddington's 'structure' being equivalent to the scholastic 'form'.

The author makes a curious slip when he says (p. 178), "To *prove* to one who denies it that two and two could not in any condition of things make five is beyond the power of any philosopher". Although this particular problem does not figure explicitly in Whitehead and Russell's "Principia Mathematica", a demonstration could undoubtedly be provided by the methods of that work.

The treatment is, generally speaking, well informed on the purely scientific side, the only noteworthy exception being that the author misconceives Heisenberg's uncertainty principle. In one place (p. 111, last three lines), he seems to be under the impression that the uncertainty is merely a consequence of the inadequacy of experimental methods now available, instead of being, as it actually is, an uncertainty *in principle*. Elsewhere (p. 24, lines 9–11) he seems to confuse it with the lack of detailed information about individuals which is characteristic of all statistical systems. But these are minor blemishes in a readable and instructive book. E. T. WHITTAKER.

# 'D.D.T.': A NEW INSECTICIDE

By PROF. J. W. MUNRO
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A STATEMENT by Government to the public Press on recent developments in the application of the insecticidal substance known as 'D.D.T.' and the extensive publicity given in the American Press and technical journals to this insecticide have directed attention to a field of work in applied entomology which in peace-time is almost unknown except to the specialists.

With the outbreak of war, and especially when Japan entered the War, the need to protect growing crops and stores of food from insect attack, and above all the need to protect the Fighting Services from insect-borne diseases, created an unprecedented demand for insecticides. In the face of that enormously increased demand, by the mere entry of Japan into the War, supplies of the important insecticide pyrethrum from that country to the United States were cut off. Worse still, with the loss of Malaya the main source of rotenone derived from *Derris elliptica*, a second important insecticide, was lost. The chief, almost the only important, source of pyrethrum left to the Allies was Kenya Colony, but its production was unequal to the war demand. A limited supply of rotenone, inferior as an insecticide to that derived from Derris, was available in South America from the plant Lonchocarpus, but again the supply was unequal to the demand. It was in these circumstances, when an urgent and active search for substitutes for pyrethrum and for rotenone was being made, that attention was turned to 'D.D.T.'

'D.D.T.' is a term coined to designate briefly the substance dichloro-diphenyl-trichloroethane, and the term 'pure D.D.T.' designates *para-para*-dichloro-diphenyl-trichloroethane, which is the most active isomer. In the trade, an insecticide containing 'D.D.T.' as the active ingredient was marketed in the United States as 'Gesarol' and in Great Britain as 'Neocid'. Neither the discovery of the substance itself nor its use as an insecticide is new; but, under the necessity of finding substitutes or near substitutes for pyrethrum and for rotenone as insecticides, new applications or uses for 'D.D.T.' have been developed both in Britain and in the United States.

'D.D.T.' has proved an unusually effective insecticide with more uses than any other single substance so far available, and has already more than justified the intensive work done on its 'development'. For example, it has been used with signal success in Italy—notably in the control of a typhus outbreak in Naples when, in January 1944, 1,300,000 civilians were dusted with 'D.D.T.' powder and within three weeks the outbreak was completely under control. This is the first occasion in medical science when a typhus outbreak has been arrested in mid-winter.

The significance of 'D.D.T.' as an insecticide can best be assessed by comparing it with other insecticides used. Briefly, these are pyrethrum, derived from the flowers of *Chrysanthemum cinerariifolium*; rotenone, derived from the roots of certain leguminous plants, of which species of Derris and Lonchocarpus are the more important; and synthetic insecticides such as the organic thiocyantes and *iso*-butyl-undecylenamide.

The outstanding feature of pyrethrum is its rapid action, technically described as 'quick knockdown'. Its defects are that, as ordinarily applied as a 'pyrethrum-kerosene' spray, it is not persistent, and that to some skins it is irritant, and susceptibility to irritation increases under continued exposure.

Rotenone lacks the rapidity of action of pyrethrum, is not suited for application in kerosene but is more effective as a dust. In this form it is more persistent than pyrethrum and does not cause skin irritation.

The thiocyanates and *iso*-butyl-undecylenamide more nearly approach rotenone than pyrethrum in their insecticidal action—they lack the 'knockdown' action; they are more toxic to man and animals, and the thiocyanates have a persistent unpleasant odour which quite seriously limits their use.

'D.D.T.', while lacking the rapid action of pyrethrum, has all the good insecticidal qualities of rotenone and the synthetics. In pure form it is practically odourless and it is remarkably persistent. When sprayed on walls at a suitable concentration, 'D.D.T.' kills any fly alighting on them up to a period of three weeks; a bed sprayed with 'D.D.T.' is fatal to bed-bugs for three hundred days, and clothing dusted with it is safe from lice for a month even after several launderings.

In agricultural and in veterinary pest control, as the tests conducted by the U.S. Bureau of Entomology and Plant Quarantine[1] show, 'D.D.T.' also shows high promise.

The truly astonishing rate at which 'D.D.T.' has been 'put through its paces' by the biologists, chemists and malariologists both in the laboratory and in the field, and the extensive demonstration of its value as a general-purpose insecticide, has led in some quarters to the assumption that 'D.D.T.' will rapidly replace all the older insecticides, and even to the assumption that much research as, for example, on the methods of testing insecticides, on the relative merits of aerosols and sprays and on the physical and physiological modes of action of insecticides, is no longer necessary. Such assumptions are unwarranted. While on the practical side 'D.D.T.' has provided a solution of our difficulties far beyond expectation, on the scientific side it has raised many problems and difficulties which, while they cannot be fully tackled in war-time, must yet be tackled before the full potentiality of 'D.D.T.' and—this is important—of the methods of using it can be realized. This demonstration of our ignorance of many factors affecting the full use of 'D.D.T.' is bound to react on the development of other insecticides. 'D.D.T.' is not the successful rival ousting all other insecticides from the field. It is a challenge to the chemists and the entomologists to develop these other insecticides by applying to them the same exhaustive and critical study that has been given under pressure of war to 'D.D.T.' Pyrethrum, for example, is still essential as an ingredient—perhaps with 'D.D.T.'—of sprays designed for the rapid destruction of mosquitoes. When peace returns, the factor of costs both in production and in application will once again become important and rival insecticides will enter the field—one called '666' has already done so[2].

It should be borne in mind that an important factor in the success of 'D.D.T.' lies in its trial and use on a lavish—by pre-war standards on an extravagant—scale, and until the War ends it will be difficult to see 'D.D.T.' and its competitors in proper perspective.

In looking forward to that time, one may express the hope that the herculean efforts now being made to destroy insect vectors of disease and depredators

of our crops and food stores will not be abandoned, as efforts on a lesser scale were abandoned in 1919. During the War of 1914–18, the most widely used specific against lice was a rather crude mixture called 'N.C.I. powder'. It is interesting to note that, according to Prof. P. A. Buxton's monograph published in 1939[3], it was still on the active list.

The neglect of applied entomology except in times of crisis has cost us dearly enough; in this present War, but for the efforts of a group of administrators and men of science working in close concert, it might have cost us even more. In the United States, Government departments, university and research institutions and individual workers themselves have described the magnificent effort they have made in this field. In Great Britain, official reticence, if not secrecy, has delayed until now any reference to the equally great effort made by workers in many fields, administrative and technical; industrial and scientific. The co-ordination of that effort and the startlingly successful development of 'D.D.T.' was possible only under able and distinguished leadership, both in the military and in the civil branches, and it is to be hoped that in due course that leadership may be acknowledged.

[1] *J. Econ. Entom.*, 37, No. 1, 125 (1944).
[2] *Farmer and Stockbreeder*, 58, No. 2847, 688 (1944).
[3] "The Louse" (London: E. Arnold and Co., 1939).

# THE VISUAL EDUCATION CENTRE, EXETER

By G. PATRICK MEREDITH

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VISUAL education starts with certain raw material in the form of items of organized knowledge (usually in verbal form); converts it into *visual matter* (photograph, diagram, etc.); presents it through some *visual medium* (wall-mount, ciné-projector, etc.); and usually combines it with oral teaching—all to help the learner to learn more efficiently than by the latter alone. At every stage problems arise. The field is wide and there are many workers in it. At the Visual Education Centre at Exeter we are endeavouring to find solutions to these problems; at its recent research conference its possibilities of usefulness, both as a research institution and as a forum, were demonstrated. (The Museum has a very important function in visual education. I have made no attempt to deal with this as it is beyond the scope of my title.)

The problems fall naturally into three main groups, concerned with visual *matter*, visual *media* and visual *methods*, respectively. The distinction between matter and media is all-important. The matter may be pictures, diagrams, pictograms, maps, symbolic charts, mathematical graphs, etc. Any of these may be presented through any of the visual media, namely, wall-mount or text-book illustration, episcope projection, diascope projection through lantern slide or film-strip, and lastly ciné-projection (silent or sound). Moving matter (ciné-film), microscopic matter and stereoscopic matter are restricted, of course, to special forms of presentation.

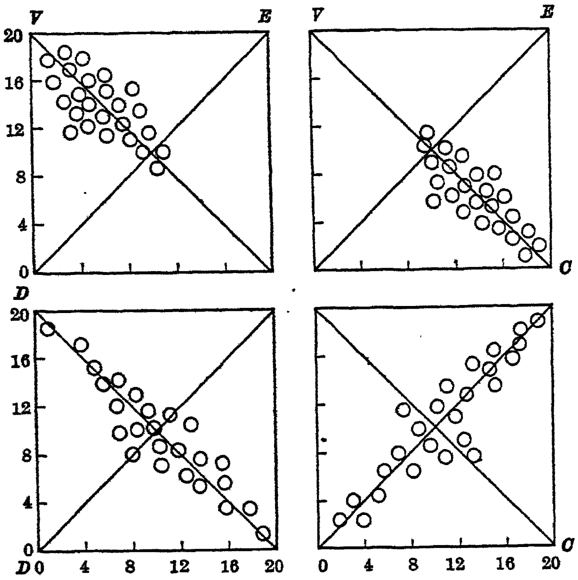
Extravagant claims for some particular medium are often made by enthusiasts who forget that we cannot get more educational value out of any material than was put into it; hence the need for the closest collaboration between film producers and educationists. Thus our major problems are with the design and supply of visual matter. These are fundamental. Next comes a series of practical problems concerning the design and supply of apparatus; training in manipulation; maintenance and repair of equipment; finance, etc. Thirdly, the use of these media has to be integrated into the work of the teacher and into the curriculum as a whole. All these problems require systematic investigation.

## Origin of the Centre

The stages by which the Visual Education Centre came into existence were briefly as follows. In 1940 I began, as a lecturer in the Education Department of the University College of the South-West, to specialize in the study of visual aids; the experience of a dozen years of science teaching had convinced me of their value. Visual education was incorporated into the diploma course and I gave students a training both in the handling of visual media and in the design of visual matter. At the same time I became secretary of the Film Council of the South-West, a recently established committee for the encouragement of the cinematograph for both instruction and entertainment. The Council represents the local education authorities, the University College, the schools, the cinema trade, the Ministry of Information and the British Film Institute. The latter, together with the local education authorities and local subscriptions, finance the Film Council. The secretaryship, at first voluntary, came to be accepted as College work, thanks to the goodwill and foresight of Principal John Murray, and of Prof. S. H. Watkins of the Education Department. Other work had to be dropped and funds raised to appoint a substitute; the director of the British Film Institute was instrumental in obtaining grants from industrial concerns, and the position was consolidated by the establishment of a lectureship in visual education. Equipment was purchased, clerical and technical assistance provided, temporary huts appropriated, and last year a research assistant, Dr. Renée Marcousé (now assistant lecturer), was appointed.

The Centre is fully occupied in training students, providing teachers' courses, supplying advice and information, providing film shows and other visual demonstrations both in the College and outside, for schools, for the Forces, for civil defence and other national services, for adult education and so on. It now issues its own bulletin, approximately quarterly. It maintains a very wide circle of contacts in all branches of visual education. Recently problems of aeronautics and industry have been insistently raised, and the setting up of an industrial section is contemplated. All along, the Centre has paid its way by grants raised *ad hoc*, now running well into four figures.

One of the Film Council's earliest achievements was the establishment of a regional film library. Dartington Hall generously provided housing and personnel. The Ministry of Information substantially aided the new library by choosing this as a regional distributing centre for the whole south-west region. Much valuable experience has been gained in this way, and the five counties have been kept supplied with non-theatrical 16-mm. films for the last three years.




ASSESSMENT OF VISUAL MATERIAL BY TEST-SCORE ANALYSIS

The small circles represent individual test-questions. In any actual distribution they are numbered, and coloured according to type. Each has two co-ordinates *C* and *V*, being the number of correct responses to the question given by the Control group and the Visual group respectively. (There were approximately twenty children in each group.)

The four distributions shown are some of the extreme distributions theoretically possible: 1 indicates a test favouring the visual group almost exclusively; 2, Control group favoured; 3, approximately half the questions favour the Visual and half the Control group; 4, few questions discriminate between the two groups.

Obviously various statistical coefficients could be calculated from the data, but the main interest lies in the indications which the method provides of the detailed 'educational yield' of a particular piece of visual teaching.

*DE* may be called the 'axis of difficulty', and *VC* the 'visual-verbal axis'.

## An Experimental Inquiry

Research, both experimental and theoretical, is the most important contribution a university centre can make. An investigation into visual teaching techniques has recently been completed in Exeter. The statistics are now being analysed, and a full report will be issued in due course. Owing to the inherent variability and multiplicity of the factors involved, the utmost caution is needed in interpreting the results of any educational experiment. A difference may be statistically significant, but the qualitative significance is often a matter of conjecture. A certain percentage difference ($\pm$ p.e.) between the average test-scores of two groups tells us very little. It is conceivable for two groups to have equal average scores and yet to have answered correctly two entirely different selections of questions. In the Exeter research particular attention was paid to the content and structure of the topics on one hand, and to the distribution of correct answers among the various test-questions on the other hand. The accompanying diagrams give four of the various theoretically possible distributions, with their interpretations. The actual distributions, still being worked out, tend to be mixed in type, as would be expected.

The research seeks detailed information of two kinds. The first is an objective educational assessment of a particular 'graphic' (to borrow a useful term introduced by Lieut.-Commander Rawnsley, covering all forms of visual material) whether film, set of photographs, etc., or combination of these. Such information is essential if visual production is ever to work by methods other than rule-of-thumb. The second is a descriptive account of the practical problems which arise in the classroom in handling 'graphics', and the solutions adopted by a number of different teachers. A comparatively small-scale experiment, closely recorded, may yield more valuable information than a much larger experiment which swamps the desired information in arrays of averages. Four schools were used. There were two groups in each, a 'visual' and a 'control'. The teachers were supplied with detailed notes of the topics and with visual materials. Initial, final and delayed tests were given. They were objective 'new-type' tests. Four different topics were chosen and each was tried out in all four schools, but the visual method was slightly different in each case. The four methods were: film alone, static pictures alone, film plus static, and segmented film plus static. (The theory of 'segments' will be given presently.) The test-questions were sub-divided under four headings according as they dealt with problems, observations (raw facts), representations (grouped facts, that is, laws) or inferences (explanations and theories). The dots representing each question in the analysis charts are coloured according to these four headings. The distribution then shows at a glance whether any one *type* of question is favoured by the visual or by the verbal method. This technique lends itself to considerable development, and promises to remove much of the subjectivity from judgments on educational materials and methods. Thus the research as a whole was not concerned with verifying any particular hypothesis but with creating techniques and obtaining valuable information.

Films often contain material which is essentially static. Such material is better presented in static form, the film medium being reserved for essentially kinetic aspects of the topic. The theory of 'segments' is that phases of growth, change, motion, etc., should be presented in short film-segments of, say, 1–3 minutes duration, for detailed study and for integration with static 'graphics'.

## Discussion of Results

The idea of research conferences is a sound one in a field where variation and multiple causation are the order of the day. The suspicion of statistics *per se* is a healthy one, but statistics submitted to a competent body of critics may yield very useful interpretations. A conference was held at Exeter during July 1 and 2 with personnel from the Board of Education, the local education authorities, the museums, the British Film Institute, the participating schools, Film Centre, Shell Film Unit, Common Ground, Ltd., Dartington Hall Film Unit, the Film Council of the South-West and the University College of the South-West. In the opening session the plan of the research was described and the "Exeter technique of visual assessment" explained by myself with coloured charts. Dr. Marcousé then gave an account of her systematic observations of the

teaching procedure and of the overt responses of the children to the visual material. (In the full report this will be given in detail.)

Next came the teachers. All four schools had shown a most gratifying willingness to co-operate. Perhaps the most interesting feature of their testimony was the unlooked-for result that, quite apart from the stimulus to the children, the use of these visual techniques had a distinctly stimulating effect on the teachers. The extremely cordial relationship between the teachers, the Visual Education Centre staff and the director of education, Mr. G. A. Tue, was the *sine qua non* of the whole research. The four Exeter schools taking part were the two Episcopal Senior and the two Ladysmith Senior schools.

The lesson notes, tests and visual materials were all on view. The latter consisted of four films and still material consisting of large photographs of high quality, well-mounted, bearing full captions, and covering the four topics. Other material was also demonstrated.

Discussion took place on classroom techniques, on the use of museum material and on the planning of educational films. Miss Grayson (of the British Film Institute) stressed the need for co-ordination. The problem of making museum resources available for the schools was discussed. Mr. Neilson Baxter (Shell Film Unit) pointed to the valuable experience gained by many ciné-technicians in the production of instructional films during the War. Mr. Anstey (Film Centre) urged the setting up of a Government films department. The present author pointed out that if producers would plan educational films in series, each series following a characteristic treatment, a prototype film for each series could be made and tried out by the Exeter technique. The evidence so obtained would provide guidance for the rest of the series. The conference was summed up by Mr. K. de B. Codrington (Victoria and Albert Museum), who stressed the simple common elements which run through all good teaching and the need for using each type of visual material for the purpose to which it is most suited.

### General Conclusions

Whatever researches are made on problems of media and methods, the fundamental problems are those of visual matter. Any visual production rests on a whole series of assumptions, conventions and decisions. No amount of technical or æsthetic virtuosity can compensate for a failure to come to terms with the philosophy of curriculum-building or the psychology of the child. One important factor often neglected is the contribution of intellectua security to emotional stability. Our existing curricula present children with an anarchic sequence of incommensurable and unintegrated approaches to knowledge. If visual education neglects its fundamentals, it may easily perpetuate this state of affairs. Theoretical research at the Visual Education Centre is therefore concerned with the bearing of three normative disciplines on visual production, namely, logic, semantics and statistical theory. Visual productions must be consistent, they must present their meaning clearly, and they must take account of the variability which all objects display. This is a long story, to be presented in a larger publication, together with an account of its bearing on the curriculum as a whole, and the significance of these new developments in relation to the teacher's function and to national (and international) educational needs.

## MATHEMATICS FOR PHYSICISTS

"MATHEMATICAL teaching," said Klein, "is a function of two variables, the subject and the pupil." In other words, it is necessary to vary the presentation of the subject to suit minds of different types. Nineteenth-century physicists, such as Kelvin and Maxwell, started as mathematicians, and many of the contemporary mathematicians relied upon physical intuition, so at that time a common course of training was possible. The interests of the two parties have now diverged. The pure mathematicians have recognized that intuition may be successful for a long time, and yet lead in the end to a terrible blunder. They now keep to the straight and narrow path of rigorous logic. For example, they do not, like Fourier, assert that any function whatever can be expanded in an infinite series of harmonic terms, but occupy themselves with the difficult task of formulating the precise conditions necessary and sufficient for this expansion.

On the other hand, experimental physicists regard mathematics as a tool, to be used whenever it is convenient to supplement the results of experiment, or as a language in which these results can be concisely expressed. To them Fourier's theorem is merely the mathematical form of a general physical principle, firmly established by experience. Why should they worry about possible exceptions which may never happen? They prefer vigour to mathematical rigour, which seems to them as devoid of live interest as *rigor mortis*. Even if they could appreciate the need for the purely logical discussion, they would not have time to study it. What has been said of Fourier's theorem applies also to the large amount of advanced mathematics which is inseparably connected with recent advances in physics. The traditional 'mathematics subsidiary to physics' is now quite inadequate, but experimental physicists cannot afford the time needed for a great extension of the mathematical course on its present lines.

To deal with this dilemma, the Institute of Physics and the Mathematical Association have held a conference and issued a joint report, "The Teaching of Mathematics to Physicists" (Institute of Physics, Spencer House, South Place, London, E.C.2). They recommend courses much wider in scope but simpler in technique than the usual subsidiary mathematics. For example, their Schedule A, which is to cover the minimum requirements of a fully trained physicist, includes roughly the contents of both the two subsidiary subjects pure mathematics and applied mathematics (which are alternative subjects at some universities, such as London), with the addition of a little statistics. This doubled syllabus is to be covered in the same time as before, say, one third of the physicist's total study hours for two years. This is to be made possible by omitting the solution of difficult problems, and merely requiring the student to recognize the applicability of the mathematics to physics. Specimen examination questions are given to show how this can be done.

The report also gives a Schedule B, suitable for the ablest undergraduates in their third year, and a Schedule C suitable for the postgraduate stage. At first sight these later schedules seem far beyond the capacity of any experimental physicist; but, as in Schedule A, it is intended that they should be treated with the minimum of technique. It is admitted that this will require special lectures and an increase in university staffs. It is suggested that such lectures

might be useful for students of other branches of science, but this has not been discussed in detail. It is recommended that the lecturer should be a member of the mathematics department, with a special sympathy towards the outlook of the physicists.

As a personal comment on these proposals, it may be stated that an optional course on these lines, as a supplement to the usual subsidiary mathematics, has been given for several years at University College, Nottingham. It seems to be appreciated by the stronger physicists, but it is rather a strain on the weaker ones. The surprising thing is that it is enjoyed by mathematicians, who apparently welcome a temporary release from the inhibitions of mathematical rigour.

H. T. H. PIAGGIO.

# BIOLOGICAL APPLICATIONS OF THE ELECTRON MICROSCOPE*

By DR. G. E. DONOVAN

ELECTRON micrographs may be considered analogous to X-ray pictures, since the darkness and brightness depend on the thickness and density of the specimen; they are unlike micrographs taken with the light microscope, in which an image is formed due to differences in the amount of absorption or refraction within the object. The presence of very small particles in specimens for examination under the electron microscope will cause perceptible scattering, and the image formed of an object thicker than about 0·5 μ is merely an enlarged silhouette.

Another characteristic, which is usually an advantage, is the great depth of focus. This is useful for stereoscopic work.

## Specimen Mounting

The vast majority of microscope specimens must be mounted upon a transparent support. Glass of a convenient thickness is the most suitable material when the illuminant is visible light, but it is opaque to an electron stream, and a new technique has therefore been built up, whereby specimens may be adequately prepared for examination. A very thin, uniform film of collodion or nitrocellulose can be produced so as to show no structure, similar to the glass slide used for supporting specimens in the ordinary microscope. It produces a uniform diminution of intensity, but if the film is thin enough, the amount of scattering and spread of velocity caused by it does not cause much interference with the picture. A very thin film is produced by dropping a small quantity of a 1·5 per cent solution of collodion in amyl acetate on water saturated with amyl acetate. The film spreading over the surface is taken up and dried on a small circular disk of 200-mesh wire gauze, less than ⅛ in. in diameter. Gentle pressure on the diaphragm causes it to adhere to the film. Films of this kind are thinner than the length of a collodion molecule. The coated disks are separated from the rest of the membrane by means of delicate handling tools, lifted from the water, inverted so as to bring the film side uppermost, and placed upon a miniature pedestal. There the water clinging to the surface is removed, and a drop of a fluid containing the specimen in suspension, or solution, is placed upon it, and the fluid allowed to evaporate. The whole is then placed in position on the 'cartridge', which in its turn is inserted through the air-lock into the microscope into the space about to be evacuated. The surfaces of certain materials, for example, metals and alloys, can be studied by light reflected from them in the light microscope, but this is generally impracticable with electron rays. A cast of the surface can be made by using some sort of plastic in solution and allowing the solvent to evaporate; a negative solid replica of the surface structure can be produced by peeling off the film from the original, and can be examined like an ordinary specimen in the electron microscope. An electron image of such a film will develop more strongly where the plastic material is thinnest. In some cases, where a replica cannot be stripped off, satisfactory results can be obtained by dissolving the original in some acid or other solution which the plastic film can withstand. The cast technique may be useful for examining the surface of such structures as metals, teeth, etc.

* From a paper on "The Electron Microscope: its Applications to Medicine" read before the Royal Society of Medicine on June 21.

## Practical Applications

Until very recently, the electron microscope remained an experimental instrument in the hands of the physicists, and it is only in the last few years that any serious attempt has been made to exploit its possibilities for research. Most of the examinations so far reported have been directed towards the discovery of possible fields of research, rather than towards the solution of particular problems. It holds great promise in almost every field of science, especially in chemistry, metallurgy, medicine and biology, as it reveals many important structures and reactions which have hitherto been inaccessible to direct observation and measurements.

Dusts and smokes are among the simplest kind of materials to view in the electron microscope, revealing groups of ultra-microscopic particles that float in the air. This type of research is of interest to the public health worker and those interested in environmental diseases, such as the medical man in industry, etc. A great number of the particles found in human lungs are smaller than 5 μ in diameter, and an appreciable portion less than 0·2 μ. Electron micrographs have been published of smoke particles resulting from the combustion of zinc, magnesium ribbon, aluminium, etc. The physical structure of these varies; for example, the electron micrograph of magnesium oxide shows small cubic crystals, aluminium oxide smoke is made up of strings of spherical globules, etc.

Powders are required for many purposes, and a knowledge of their physical structure is of importance. A sample of lead arsenate insecticide which possessed unusual covering power and toxicity showed under the electron microscope, magnification 56,500, that the particles consisted of extremely thin flakes, which naturally possess a large surface and clinging power. A popular face powder owed much of its popularity to the fact that it did not easily come off. The electron microscope showed that its particles were of a highly angular shape, capable of hooking themselves into the epidermis.

The instrument has many uses in organic chemistry; for example, an electron-micrograph has been published[1] showing a specimen of polyvinylchloride. The magnification (100,000) shows the specimen to be mottled with an evenly spaced succession of spots. The spots are considered small enough to constitute single molecules, and there is little doubt that visual

confirmation is here obtained of the truth of the molecular theory. It has been used in the study of protein molecules[2].

It is now possible to obtain electron micrographs of the location of certain chemical reactions incident to the metabolism of the bacterial cell. The reduction of potassium tellurite by *C. diphtheriæ* has been studied[3]. It has been demonstrated that tellurium crystals form in all parts of the micro-organism, in some cases puncturing its walls. A method of selective micro-chemical analysis has been developed[4] by taking electron pictures of bacteria after exposure to salts of heavy metals. The electron microscope has demonstrated changes in the bacterial cell brought about by the action of germicides and anti-bacterial substances[5]. The recording of the action of germicide agents on individual bacterial cells is a promising field of application of micro-chemical analysis.

Electron micrographs of bacteria have been published[6]. The *Myobacterium tuberculosis hominis* shows that its cell wall appears to be very delicate. Many small dark granules appear throughout the field, and in particular, adhering to the cell wall. Large black granules are shown within the protoplasm. A strain of Fusobacterium shows dense areas, but in contrast to that of the tubercular bacilli the dense areas are not localized in definite circumscribed granules. Monotrichates, for example, *Vibrio schuylkiliensis*, show a cell wall. Definite circumscribed granules are again seen within the protoplasm. The flagella of monotrichates—for example, vibrios—are on the whole wider in diameter than those of peritrichate and lophotrichate species. Unstained diphtheria bacilli show definite polar bodies. *Treponema pallidum* appears to have flagella-like processes at various points along its course. The morphology of *Leptospira ictero-hæmorrhagiæ* and *L. canicola* has been investigated[7].

If suspensions of streptococci are subjected for a short period to sonic vibrations, some of the cells are cytolysed[8]. These bacteria retain their original outline, but become transparent to the electron beam, appearing as pale grey bodies and contrasting strongly with the opaque normal cell. *B. subtilis*, after subjection to sonic vibrations, is shown to have the flagella continuous with the cell wall.

The combination of antibodies with flagella and somatic antigens has been demonstrated by the electron microscope[4]. It has long been known that the bacterial cell wall and flagella of organisms such as the bacilli of typhoid and paratyphoid are altered by the deposition of antibodies, and the combination of antibodies and antigens at bacterial surfaces has also been shown by quantitative analytical methods. These sensitized surfaces have now been examined under the electron microscope, and, as a result of the deposition of homologous antibodies upon them, the walls are found to become opaque, and less clear-cut in outline. The flagella become thicker, but less sharp and less uniform in outline, and they tend to coalesce.

The various viruses differ greatly in size, although each kind of virus is itself very uniform in size. During the last decade, a few of the viruses which attack plants have been isolated. Although they differ from each other in stability and analytical composition, all those purified have been shown to consist solely of nucleo-proteins of high molecular weight. These viruses seem to be a connecting link between living and non-living matter. They are actually protein molecules possessed of certain definite biological activity. On the other hand, there are viruses, that of vaccinia, for example, and all the Rickettsia disease agents, which are very much larger, and cannot be regarded as single molecules. The larger viruses appear to be true micro-organisms which can only live a parasitic existence. One of the first viruses to be photographed under the electron microscope was that of tobacco mosaic, and it at once confirmed the suggestions, based on other methods, about the size and shape of this virus. It was a rod about 300 mμ long. Particles of tobacco mosaic virus appear in purified form as discrete rod-like units with a tendency to side-to-side and end-to-end aggregation. The electron microscope has also been used in the study of the virus of tomato bushy stunt. The reaction between tobacco mosaic virus and its antiserum has been studied by means of the electron microscope[9]. This instrument has been used in the investigation of the morphological structure of the virus of vaccinia[10]. The elementary bodies of vaccinia are rectangular in shape, resembling a brick, and contain five areas of condensation, and are somewhat like the five spots of a dice. Sharp[11] and his colleagues have employed the electron microscope in their investigations of Western strain equine encephalomyelitis virus. Taylor and his associates have used this instrument on the Eastern strain equine encephalomyelitis virus. Studies have been published[12] on the nature of the virus of influenza with particular reference to the dispersion of the virus of influenza A in tissue emulsions, and in extra-embryonic fluids of the chick. The size of the infectious unit in influenza A has been investigated[13]. This instrument has been employed on the morphological structure of rickettsiæ[14]. It has also been used in studies on the papilloma virus protein[11].

Studies of bacteriophages[15] disclose an extremely constant and characteristic sperm-like appearance with a round head, and a much thinner tail; in many micrographs the head is filled with a dense internal structure. These are adsorbed to their specific micro-organisms by head or tail, and, after contact, it is possible to observe extensive damage of the bacterial cell. These results are interesting, as some years ago the bacteriophage was looked upon by some workers as of macromolecular nature. The discovery of such constant and detailed information is of interest also to geneticists, for genes are thought to be macromolecular entities. The sperms of the lamb and bull, due to their extreme flatness, are amenable to examination, and have already come under observation.

The electron microscope is of value in histological research. It has revealed characteristic cross-striations in collagen fibres, and the effects of various physical and chemical conditions on the fibres has been investigated[16] in a search for further knowledge of the molecular structure of collagen. To entomologists, this instrument shows hitherto unseen structures, and it allows the accurate measurement of those already recognized. The tracheæ, trachioles, air sacs, wing scales, and cuticle have been examined, and experiments[17] on the mode of penetration of the cuticle by non-volatile oils serve as an example of future useful applications.

The foregoing are only some of the many fields in which an electron microscope is useful.

## Some Disadvantages

The electron microscope is not yet an instrument for every pathologist's bench, due to its cost, size and complexity. Its immediate future lies rather in

the research laboratory. The bombardment of specimens with high-speed electrons produces changes in protoplasm, and in molecules. Entomologists have remarked on shrinkage, evolution of gas, discoloration, and increased friability of their specimens. As the specimen for study must be placed in a high vacuum it must, therefore, be dry. Great difficulty is experienced in viewing anything but 'dead' specimens, and in consequence, movement must inevitably be 'frozen', and require a number of successive and similar operations to show progressive action. The objects to be examined must be extremely thin.

### Some Further Developments

Due to the very small aperture of the electron rays, the electron microscope shows a surprisingly large depth of focus. Electron stereomicroscopy has been suggested by E. Ruska. M. v. Ardenne[18] has further developed this idea, and introduces in his electron microscope a particular object carrier which can be tilted by a few degrees between two successive exposures. A vivid impression of solidity is produced if the two corresponding photographs are examined under a stereoscope.

v. Ardenne has successfully applied dark-ground illumination and obtained resolving powers down to $5 \times 10^{-7}$ cm., and he discusses[19] in this connexion the possibility of viewing single atoms, and studying their distribution in the object plane. There are, however, great practical difficulties; for example, the exposure time would have to be increased more than 1,000 times if ultra-microscopical methods were to be introduced.

O. Scherzer[20] discusses the possibility of improving the resolving power of the ordinary electron microscope with direct illumination by an improvement of the electron lenses leading to larger numerical apertures. He mentions in this connexion the practicability of correcting spherical aberration by introducing space charges into the lens. F. H. Nicoll in his patent proposal of 1936 discusses the introduction of an electron mirror into the instrument. As it is feasible to construct mirrors with negative aberration, a useful opportunity of correcting the mirror-microscope is given.

The most direct method of improving the resolving power is to use appreciably greater electron energies, and thus shorter wave-lengths. There is an upper limit to what we can hope for in this direction.

After the War is ended, there should be great developments in television, and some of this research work will be employed in improving the electron microscope.


[1] *Trans. Amer. Inst. Elect. Eng.*, April 1940.
[2] Stanley, W. M., and Anderson, T. F., *J. Biol. Chem.*, **146**, 25 (1942).
[3] Morton, H. E., and Anderson, T. F., *Proc. Soc. Exp. Biol. (N.Y.)*, **46**, 272 (1941).
[4] Mudd, S., and Anderson, T. F., *J. Exp. Med.*, **76**, 103 (1942).
[5] Mudd, S., *Amer. J. Publ. Health*, **33**, 167 (1943).
[6] Mudd, S., Polevitzky, K., and Anderson, T. F., *Arch. Path., Chicago*, **34**, 199 (1942).
[7] Morton, H. E., and Anderson, T. F., *J. Bact.*, **45**, 143 (1943).
[8] Sheffield, F. M. L., *School Sci. Rev.*, **25**, No. 96, 201 (1944).
[9] Anderson, T. F., and Stanley, W. M., *J. Biol. Chem.*, **139**, No. 1, 339 (1941).
[10] Green, R. H., Anderson, T. F., and Smadel, J. E., *J. Exp. Med.*, **75**, No. 6, 651 (1942).
[11] Sharp, D. G., Taylor, A. R., Beard, Dorothy, and Beard, J. W., *Proc. Soc. Exp. Biol. and Med.*, **50**, 205 (1942); **51**, 205 (1942); **51**, 332 (1942).
[12] Chambers, L. A., and Henle, W., *J. Exp. Med.*, **77**, 251 (1943).
[13] Chambers, L. A., Henle, W., Lauffer, M. A., and Anderson, T. F., *J. Exp. Med.*, **77**, 265 (1943).
[14] Plotz, H., Smadel, J. E., Anderson, T. F., and Chambers, L. A., *J. Exp. Med.*, **77**, 355 (1943).
[15] Luria, S. E., and Anderson, T. F., *Proc. U.S. Nat. Acad. Sci.*, **28**, No. 44, 127 (1942).
[16] Hall, C. E., Jakus, M. A., and Schmitt, F. O., *J. Amer. Chem. Soc.*, **64**, 1234 (1942).
[17] Richards, jun., A. Glenn, and Anderson, T. F., *J. Morph.*, **71**, No. 1, 135 (1942).
[18] v. Ardenne, M., *Z. Phys.*, **115**, 339 (1940).
[19] v. Ardenne, M., *Z. Phys.*, **112**, 744 (1939).
[20] Scherzer, O., *Z. Phys.*, **114**, 427 (1939).


# NEWS and VIEWS

### Dr. W. K. Gregory

DR. W. K. GREGORY has recently retired under an age limit from the staff of the American Museum of Natural History. For some forty years he occupied a very special place in that great institution, for his knowledge of comparative anatomy extended over the whole range of vertebrates, both recent and fossil, and his philosophical mind led him to make wide ranging comparisons and detailed analyses of structure which have contributed very greatly to our understanding of structure and especially of the course of evolutionary processes. His early works on Tritubucular teeth and on the orders of mammals were of great importance, and were but the harbingers of many others which have since appeared. During the past twenty years his immense experience of mammalian structure has enabled him to contribute much to our understanding of the significance of the many fossil human skulls which have become known, and he has at the same time devoted much attention to the detailed structure of modern fish. But Dr. Gregory's retirement is only from his formal position; relieved of administration he may, we hope, continue even more actively his own researches.

### Prof. James Drever

PROF. JAMES DREVER has recently retired from the chair of psychology in the University of Edinburgh, which he has held since its foundation in 1931. In 1918 he was elected to the Coombe lectureship in psychology at Edinburgh, and in 1924 he became University reader. When lecturer he had eighty students, and an assistant to help him. Shortly before the present War, the number of his students had increased to nearly six hundred, and his staff comprised a reader, two lecturers and four instructors. Prof. Drever graduated in arts in Edinburgh in 1893 and spent two years in studying medicine. Owing, however, to various difficulties he was then compelled to become a schoolmaster. But in 1907 he became assistant to the professor of education at Edinburgh, where he founded the Educational Laboratory, taking a keen interest in problems relating to human instinct, in the treatment of delinquent and difficult children, and in the institution of the degree of bachelor of education and of postgraduate psychological research for students of education. These early efforts led to his later work on the psychological treatment of the psycho-neuroses, on developing performance tests of

intelligence, on colour-blindness, and on instituting university teaching in medical and industrial psychology. His son has been appointed by the University to succeed him in his professorship.

## Industrial Relations and the Cost of Living Index

A BROADSHEET "Wages and the Cost of Living Index" (No. 220) issued by Political and Economic Planning gives a useful brief review of the cost of living index itself and of the wage systems in the building and civil engineering, railways, iron and steel, coal and cotton industries and the Civil Service in Great Britain. The broadsheet forms part of a report on industrial relations which P E P is preparing, and does something to meet the need for a study of wages and other aspects of industrial relations which such innovations as 'pay-as-you-earn' have intensified. In addition to its descriptive part, the broadsheet includes the general conclusion, first, that if wage policy were sufficiently well co-ordinated between workers and employers and between different industries, it could be arranged that wages should not fall as much as prices during the down-swing, and that in return they should not be pushed up so much when prices are once more rising. Such a policy has been put into practice in Sweden with results that open up a vista of possible 'trade-cycle bargaining', under which the application of sliding scales as we know them would be inappropriate. From the workers' point of view it would be wrong to peg wages to the cost of living and thus stabilize real wages when their productivity is increasing and prices falling, for this would mean that their share in the product of their labour would be declining. One may expect that if post-war employment succeeds in producing a steadily rising national income, workers in most industries will prefer to rely on their bargaining power rather than on automatic scales. Part of the dynamic of a full employment policy must be the general striving for an uninterrupted rise in the standard of living, and therefore in real wages.

Where the workers in an industry have little expectation of increasing their standard of living, they may decide that the sliding scale will at least help to maintain their real wages. What is good for one industry, however, may not suit another; and the different sliding-scale schemes have different effects on the internal wage structure of the industries concerned. Cost of living calculations will remain of the greatest importance whether or not an automatic sliding scale is used. The minimum or subsistence allowance, in terms of money, for example, fails of its purpose unless it is adjusted to cover changes in the prices of the goods needed for subsistence, and for this purpose the sliding-scale method will continue to have an obvious justification. It would seem, however, that the avowed purpose of the index, to estimate changes in "the cost of maintaining unchanged the pre-war (i.e., pre-1914) standard of living of the working-classes" has not much relevance to present-day requirements, and that separate indexes are required for various income groups and for different localities. If authoritative indexes of this kind could be provided, much that is at present contentious guesswork in wage negotiations would be based on measurement and calculation, and the application of an accurate series of cost of living indexes would not be confined to wages but should form an essential part of national statistics.

## Sunspots and Human Affairs

Two papers by W. G. Bowerman (*Pop. Astron.*, **52**, March, April, May, 1944) discuss the rather indefinite subject of the relations between sunspots and terrestrial conditions. The first illustrates a close parallelism between sunspot numbers and the total mortgage loans on residential property in the United States. This held during 1923–38 but broke down in 1939, presumably owing to the disturbance caused by the War. The second and longer paper describes in a 'popular' manner the quasi-periodic nature of outbreaks of sunspots and a good deal of recent American literature on relations between sunspot numbers and extremes of temperature and precipitation, as well as such indirect effects as industrial activity, forest fires and outbreaks of tropical diseases. The author accepts the views of Ellsworth Huntington and C. A. Mills that the major economic and cultural cycles of historical times result from long-period oscillations of solar activity, acting through *average* temperature, which in turn controls both the spread of disease organisms and the power of man to resist or cope with them. Within the 11-year cycle there is a 'sharp upthrust' of temperature near sunspot minimum, but the relations are complicated by volcanic eruptions.

The whole subject of the reaction of man with his environment is of considerable interest and importance to students of human affairs; but it is far too complex for superficial or partial studies to have any value. For example, the author refers casually to the effect of air-conditioning of hospitals in counteracting climatic control of disease; but he overlooks Major Markham's hypothesis that the poleward march of civilization is a function of the efficiency of house-warming. There is room here for a new system of philosophy, but the first necessity is to verify and comprehend the facts.

## Structure and Classification of Bees

THE *Bulletin of the American Museum of Natural History*, **82**, 1944, contains a very comprehensive memoir on the above subject, written by C. D. Michener, an assistant curator of the Museum. The method which the author has adopted is to make a detailed study of the morphology of a single species of bee, for example, *Anthophora edwardsii*, and then to compare numerous other bees with this species. Finally, with these comparisons as a basis, the author gives an account of the interrelationships of the various groups of bees followed by a general scheme of classification. The latter deals with all groupings, from families to genera, represented in America north of Mexico. The memoir is one intended for the specialist on the order Hymenoptera. The anatomical section is concerned with external organs and parts only; the internal organs and musculature being outside the scope of the work. A certain number of new terms are used including the expressions mesosoma and metasoma for the regions commonly referred to as 'thorax' and abdomen respectively. Six families of bees are recognized. The Colletidæ and Halictidæ are the two oldest groups. The next in order of antiquity are considered to be the Andrenidæ and Apidæ followed doubtfully by the Megachilidæ. The last family—the Melittidæ—is too imperfectly known to suggest its position in the series. The largest family is the Apidæ which is held to include a large number of bees usually considered to be outside its limits. The author mentions that cer-

tain of these have often been placed in separate families largely on the basis of the presence or absence of the pygidial plate. This character is regarded as being unreliable since it is often lost in very different bees.

## Glossary of Communicable Diseases

A LIST of terms in the main European languages and in Latin denoting the various communicable diseases has recently been published ("Lexique Polyglotte des Maladies Contagieuses" (Polyglot Glossary of Communicable Diseases). By Dr. Yves Biraud. (London: Allen and Unwin: League of Nations Publications Dept., 1944. Pp. 354. 4*s*.). The author states in his introduction that circumstances did not allow of the sending of *questionnaires* to medical authorities of the various countries or of submitting proofs of the Glossary to them. This is quite obvious, and anyone looking for an accurate guide of this type will be well advised to await the appearance of a heavily amended second edition.

The term communicable is very widely interpreted, and the lists include appendicitis and Ludwig's angina, osteomyelitis and pemphigus of unspecified type. Catarrhal jaundice is listed twice, although this probably erroneous term for infective hepatitis is now nearly obsolete. Herpes zoster and herpes febrilis are given as synonyms. Chancroid, the most specific and commonly accepted name for soft chancre, does not appear. In the section on syphilis the terms for various manifestations do not correspond in the columns for the different languages.

## Sulphadiazine Treatment of Meningitis

ACCORDING to the U.S. Office of the Surgeon General, a saving of 90 out of 100 soldiers from death by meningitis has been achieved by sulphadiazine. The death-rate from meningitis in the U.S. Army in the present War is less than 3 per cent, whereas it was 93·2 per cent in the Revolutionary and Civil Wars and 39·2 per cent in the War of 1914–18. According to the U.S. Army Commission on Meningitis, as little as two grams of sulphadiazine will banish the germs from the nose and throat of most persons for a period of several weeks.

## Pole Treatment

IN an article on ground-line treatment of standing poles (*Bell Lab. Rec.*, 22, No. 11; July 1944), C. H. Amadon discusses the preservative method developed by Bell System engineers. External deterioration of an untreated pole in service begins in the ground section with infection by wood-destroying fungi which, once established, continue there unless adverse conditions are imposed, as for example, by the application of a suitable wood preservative. Two general classes of preservatives might be used for ground-line treatment, (1) oily materials such as creosote, and (2) water solutions of toxic salts such as zinc chloride and sodium fluoride. Sodium fluoride is particularly good for penetrating the heartwood of cedar and chestnut timbers, but it is not permanent. Creosote or creosote and coal tar, although not as penetrating as the water-soluble salt, is as lasting as any preservative known.

Beginning in 1935, Bell Laboratories engineers treated experimentally a total of 428 poles and posts with coal-tar creosote and other coal tar products, sodium fluoride, sodium silico-fluoride, and proprietary pastes and solutions containing preservative compounds. Periodic examinations and accumulated evidence during five years showed that treatment at the ground line with sodium fluoride and a mixture of creosote and coal tar is highly effective. This treatment effectively reduces the rate of deterioration of poles in line, and their service life (ground line condition) will be increased by about six years. This is sufficient to justify the costs involved, but an additional saving accrues from the possibility of placing pole line inspection on a six-year instead of the usual three-year cycle. The cumulative result of the ground-line treatment is a reduction in labour and expense of pole line maintenance-inspection and in the need for new poles.

## Paint Drying by Radiant Heat

IMPERIAL CHEMICAL INDUSTRIES, LTD., has recently issued a handy twenty-page booklet on this subject for the purpose of providing information on the properties of radiant heat, to indicate how these apply to the different types of plant now available for stoving paints, and how the qualities of the paints used are affected by the process. The chapter contents of the booklet relate to heat transfer, radiant heat, methods of drying paint, radiant heating equipment, radiant heating technique, and paints and radiant heat. Copies of the booklet may be obtained, free of charge, from I.C.I., Ltd., Belmont, The Ridgeway, Mill Hill, London, N.W.7.

## Seismology in China

IT is learned (*Earthquake Notes*, 15, Nos. 3 and 4; 1944) that the active recording of earthquakes is being continued in China. The Japanese invasion caused the National Geological Survey of China to change its headquarters to Chungking. The seismograph station at Chiufeng had to be abandoned. Dr. S. P. Lee has re-established the seismological work at Pehpei near Chungking. He has built a one-component instrument (north-south), which is being operated with a period of 4·5 sec. Recording began in October 1943.

## University of Bristol

THE following appointments in the University of Bristol have recently been announced:

Dr. J. E. Harris, to be professor of zoology in succession to Prof. C. M. Yonge, who has been appointed Regius professor of zoology in the University of Glasgow.

Dr. Wilson Baker, to be Alfred Copper Pass professor of chemistry in succession to Prof. E. L. Hirst, who has been appointed professor of chemistry in the University of Manchester.

Dr. A. G. Pugsley, to be professor of civil engineering in succession to Prof. J. F. Baker, who is now professor of mechanical sciences in the University of Cambridge.

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ERRATUM.—Sachchidananda Banerjee writes, in connexion with his communication "Effect of Vitamin C on the Adrenaline Content of the Adrenal Glands of Guinea Pigs" in *Nature* of April 29, p. 526, the phrase "The adrenal glands were extracted with trichloracetic acid for adrenaline and ascorbic acid according to the method of Rees[3]" should read: "The adrenal glands were extracted with trichloracetic acid for adrenaline and ascorbic acid according to the method of Barker and Marrian[2]. The adrenaline was estimated chemically by the method of Rees[3]".

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Relationship between Sulphonation and Desulphonation

THE familiar process of recovery of aromatic compounds from their sulphonic acids is probably almost universally regarded as one of hydrolysis. We have, however, confirmed our expectation that it might be more correctly comparable with the ordinary Dumas process of decarboxylation, and so involve their anions rather than the acids themselves; for a kinetic study of the desulphonation of *m*-cresolsulphonic acid in 90 per cent acetic acid containing also hydrobromic or sulphuric acid showed its velocity to be independent of the concentration of the sulphonic acid, to conform to the first-order equation and to be proportional to the hydrogen ion activity of the solution, but independent of the nature of the inorganic anion. Sulphonic acids of mesitylene, phenol, *p*-cresol, and 4-nitrodiphenylamine, exhibited a similar behaviour.

We must therefore formulate the recognized reversible relationship between sulphonation and desulphonation as follows:

$$Ar.SO'_3 + H_3O^{\cdot} \rightleftharpoons Ar\begin{cases} SO_3 \\ H\ldots OH_2 \end{cases} \rightleftharpoons Ar.H + H_2O.SO_3$$

(I)

Sulphonation and desulphonation are thus essentially determined by the distribution of the acids, proton and $SO_3$ (in the Brönsted-Lowry sense), between the bases phenyl anion and water. Similarly the absence of oxygen exchange between sulphate ions, unless sulphuric acid be present[1], shows that here also the essential reaction is the distribution of $SO_3$ between $H_2O^{16}$ and $H_2O^{18}$ or, as it may be regarded, sulphonation of the two types of water:

$$H_2O^{18} + O_3S\,.\,O^{16}H_2 \rightleftharpoons H_2O^{18}.SO_3 + O^{16}H_2.$$

The conclusion at which we arrive in this manner, that sulphonation directly involves $H_2O.SO_3$ rather than $SO_2(OH)_2$, accords with the suggestion of Benford and Ingold[2] that nitration involves $(H_2O.NO_2)$, and the deduction by one of us[3] that nitrosation involves $(H_2O.NO)$.

Furthermore, it will be seen that in the transition complex (I), water contributes to completion of the sulphonation forces by removal of the proton in the same way as it was suggested nitrite ion does in nitrosation[3]. This is in line with the observations of Martinsen[4] on velocities of nitration and sulphonation.

This brief discussion will perhaps serve to illustrate the wider implications of our experiments for the general problem of substitution. It need scarcely be pointed out that reversibility of the sulphonation process is much facilitated by the negative charge of the sulphonate ion. The lack of such a charge in other cases commonly inhibits reversibility; but it is familiar in the cases of nitramines and chloramines, as well as sulphamic acids; and even neutral nuclear substituents may be readily displaced by proton if, for example, steric influences provide the necessary facility for attachment of proton to the nucleus[5].

It is hoped to publish a more detailed account of this work elsewhere.

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[1] Winter, Carlton and Briscoe, *J. Chem. Soc.*, 31 (1940). Mills, *J. Amer. Chem. Soc.*, **62**, 2833 (1940).
[2] *J. Chem. Soc.*, 955 (1938).
[3] Kenner, *Chemistry and Industry*, **60**, 443 (1941).
[4] *Z. Phys. Chem.*, **50**, 385, 435 (1904); **59**, 605, 634 (1907); **62**, 713 (1908).
[5] Compare, Baddeley, *Nature*, **144**, 444 (1939).

## Rod and Cone Responses in the Human Eye

THERE is abundant evidence to show that the human eye has two distinct receptor mechanisms, one for vision in bright daylight and the other for vision at night. The sensitivity of the former, the photopic mechanism, is greatest for the longer wavelengths and is not much changed by dark adaptation. That of the scotopic mechanism is greatest for green and blue, and may be increased or reduced a thousandfold by keeping the eye in darkness or light. From their distribution in the retina and in different animals, the cones are thought to be the photopic receptor organs and the rods the scotopic.

A new kind of evidence for the 'duplicity theory' has recently appeared from records of the potential changes developed in the human eye. Such records have been made before without adding much to what can be learnt from animals; but with modern technique the human electroretinogram can be seen to depend on two receptor systems with the characteristic photopic and scotopic properties. Leads have been taken from an electrode on the cheek and from a moist thread in contact with the front of the eyeball. The eye is exposed to a large field lit by brief flashes of light and the potential changes are recorded by an ink-writing oscillograph. With red light, which should stimulate mainly the cones (Wratten monochromatic filter No. 70), the response is a brief diphasic change, the cornea becoming initially negative (Fig. 1*A*). This response is very little affected by dark adaptation, though there is some increase in the first few minutes. With blue light, which should stimulate mainly the rods (Wratten filter No. 76), the response is a slower monophasic change with a longer latency (Fig. 1*B*). This response is

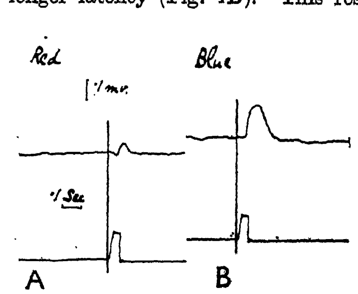


FIG. 1. *A*: ELECTRIC RESPONSE OF THE EYE TO A FLASH OF RED LIGHT. WRATTEN FILTER No. 70. CENTRAL WAVE-LENGTH 690 mμ. *B*: RESPONSE TO A FLASH OF BLUE LIGHT. WRATTEN FILTER No. 76. CENTRAL WAVE-LENGTH 440 mμ.

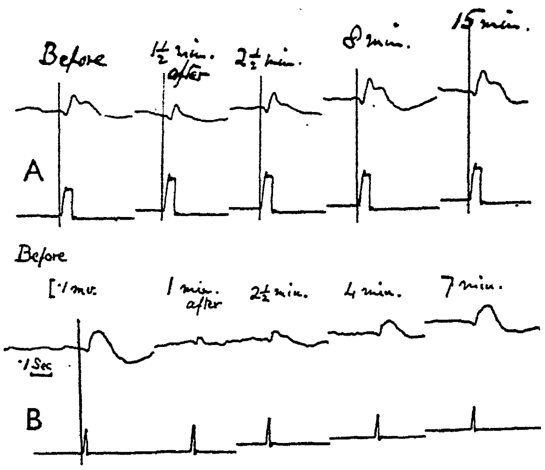


Fig. 2. EFFECT OF LIGHT ADAPTATION ON THE RESPONSE TO ORANGE-RED AND GREEN LIGHT.

*A*: WRATTEN FILTER NO. 71. CENTRAL WAVE-LENGTH 640 $m\mu$.
*B*: WRATTEN FILTER NO. 73. CENTRAL WAVE-LENGTH 575 $m\mu$.

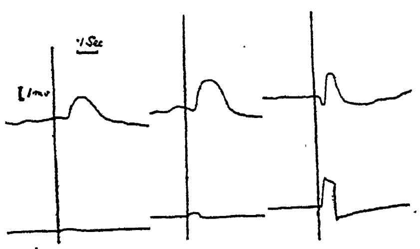

Fig. 3. RESPONSE TO FLASHES OF WHITE LIGHT OF INCREASING INTENSITY.

greatly affected by dark adaptation: it may be too small to detect (that is, less than about 20 microvolts) in the first few minutes after the eye has been exposed to a bright sky, but it will then increase steadily as dark adaptation proceeds, reaching 300 microvolts or more after 20 minutes.

With light of intermediate wave-length, the response seems to be compounded of both the rapid and the slow effects. The relative size of the two components depends on the degree of dark adaptation and can be varied by restricting the field to the central or peripheral parts of the retina, by altering the duration of the flash, or, with repetitive stimuli, by altering the frequency. Under standard conditions, the slower component is greatest with green-blue light and the rapid diphasic component with orange. The dual character of the response can be seen from Fig. 2, which gives a series of records made with orange-red light (Wratten filter No. 71) and another with green (filter No. 73). Initially the eye is moderately dark adapted, and the slow part of the response is prominent, more so in the records with green light since the slow component is relatively larger with green. Exposing the eye for a few minutes to a bright sky abolishes the slow effect, leaving only the initial diphasic response, but the slow component reappears after a few minutes and becomes larger and larger as dark adaptation proceeds.

With white light of moderate intensity the response has both components, since there is the initial negativity as well as the slower positive wave which can be increased by dark adaptation. With a bright flash, however, the slower component can no longer be seen (Fig. 3). The change in form suggests that at high intensities the photopic mechanism inhibits the scotopic, though other explanations are possible. When red or blue light is used, the form of the response, rapid or slow, is unaffected by a change in intensity within the limits of the apparatus in use.

The idea that the electric response of the retina has both a rod and a cone component is not new: it has been advocated particularly by Chaffee, Bovie and Hampson[1], but in animals other than man it has been difficult to establish a clear separation. It is easier to do this in man because the sensory performance of the human eye is so much better known.

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[1] Chaffee, E. L., Bovie, W. T., and Hampson, A., *J. Opt. Soc. Amer.*, 7, 1 (1923).

## Proteases of Takadiastase

SOLUTIONS of takadiastase (Parke, Davis and Co., Ltd.) split casein, gelatin, leucylglycylglycine, leucylglycine and chloroacetyltyrosine. The same substrates undergo hydrolysis when the enzyme solutions are subjected to prolonged dialysis in 'Cellophane' bags against running tap water. If, however, the dialysed solutions are filtered by suction through kieselguhr layers, only leucylglycylglycine of all the above substrates is split. The addition of dialysate, inactivated by heating, does not restore the activity of the filtrates towards the other four substrates.

The carboxypolypeptidase component appears to be relatively stable, for the dialysed solutions retain about 50 per cent of their activity towards chloroacetyltyrosine after being kept at 37° for ten days. Under the same conditions, the dialysates lose 70–80 per cent of their activity towards casein and gelatin, whereas the activity towards leucylglycylglycine remains almost unchanged.

Leucylglutamic acid anhydride is not hydrolysed by the dialysates or by the undialysed solutions.

A detailed report on the foregoing and further experiments with the proteolytic enzymes of commercial takadiastase will be published elsewhere.

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## Terminology of Lipoid-Protein Complexes

IN an otherwise excellent review by Lovern[1] a statement occurs on p. 32 that demands correction. In discussing the terminology of lipoid-protein complexes, Lovern rejects Macheboeuf's term 'cénapse', in favour of 'complex', claiming that the English spelling of 'cénapse' is 'synapse', to which anatomy has a prior claim.

'Cénapse' was compounded by Macheboeuf[2] from the Greek κοινός (= common) and ἅπτειν (= to fasten, tie, bind or join), with the meaning of union, bonding, binding, joining, etc. ("liaison, jonction").

It would be correctly anglicized not as 'synapse' but as 'cœnapse' or 'cenapse', and pronounced 'seenaps'. κοινός, with the meaning of 'common', anglicized to cœn- or cen- and pronounced 'seen-', occurs in many zoological terms, cœnœcium, cœnosarc, cœnosteum, cœnobium, cœnure, as well as in the more common words cœnobite or cenobite and cœnoby or cenoby. 'Synapse', pronounced in English 'sinaps', occurs with the same meaning and spelling in English as in French. It is derived ultimately from συν (= together), and ἅπτειν means literally a connexion or joining and may profitably be left with its specialized meanings to anatomy and cytology. By etymology, spelling and pronunciation, cœnapse and synapse are therefore distinctive, although their primary or literal meanings are very close.

Macheboeuf (p. 29) defines the meaning of cœnapse as follows: ". . . le terme cénapse que je propose ici s'applique non seulement aux produits créés par la saturation de telles valences residuelles*, mais encore aux produits créés par d'autres forces d'union quelles qu'elles soient, à condition que ces forces en unissant les constituants du cénapse en masquent ou modifient certaines des propriétés". Although he himself makes no claim to this ("cénapse . . . ne prejuge rien du mode de liaison") it could be argued in defence of 'cœnapse' that the prefix 'cœn-' readily suggests common or shared bonding mechanisms, that is, shared electrons of normal and particularly co-ordinated covalency, to which the more stable cœnapses such as Macheboeuf's C.A.M. are probably due; and it is not incompatible with the idea of mutual electrostatic attraction between homologous 'hydrocarbon functions' of proteins and the polymethylenic chains of lipoids, which Macheboeuf postulates to explain the less stable cœnapses. On the other hand, the meaning of 'complex', which etymologically evokes only the idea of intricate folding or entwining together, although precise enough as defined by Werner, is used in biochemistry very loosely to cover a variety of badly defined physico-chemical systems. However, my object is not so much to define 'cœnapse' against 'complex', on the grounds of precision, as to point out that Lovern's objection to 'cénapse', being founded upon an error of anglicization, is not valid.

While on the subject of etymology and correct anglicization, it seems worth while to direct attention to a misspelling of the term 'hydrophilic' as 'hydrophylic' which occurs repeatedly on p. 19 of Lovern's review and which occurs also in a communication in *Nature* by McFarlane[3]. Hydrophilic, from ὕδωρ (= water) and φιλεῖν (= to love"), hence 'water-loving', is of course the correct form in English, as is 'lipophilic', which is misspelled as 'lipophylic' in Lovern's review.

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* In reference to Willstätter's use of the term 'symplex' for compounds between protein and glycogen, etc., by means of secondary valencies.

[1] Lovern, J. A., D.S.I.R. Food Invest. Spec. Rep. No. 52. (London: H.M. Stationery Office, 1942.)

[2] Macheboeuf, M., "Etat des lipides dans la matière vivante. Les cénapses et leur importance biologique". "Actualités scientifiques et industrielles", No. 448. (Paris: Hermann et Cie, 1937.)

[3] McFarlane, A. S., *Nature*, 149, 439 (1942).

## Standardization of Root Excretions for Immunity Trials on the Potato Root Eelworm

EXPERIMENTS with South American species of potato, carried out since 1941, have shown that, compared with British species, the South American plants are generally far less strongly attacked by the potato root eelworm; nor do their root excretions stimulate to the same extent the emergence of larvæ from the cysts. A full account of this work will be published in due course. It seemed desirable, however, to describe the method recently developed in an effort to test whether the differences in excretions were truly specific, and not due to variations in the vigour of the material available for test: it was thought that this might be of use in other fields of eelworm research.

Until more is known of the nature of root excretions, their standardization, in the chemical sense, is clearly impossible. In the present method the oxygen consumption of the roots is used for standardizing the solutions of root excretions, the assumption being made that the rate of production of the latter is related to the metabolic rate. Other activities, such as growth hormone production, might similarly be used; but the former appears to be particularly suitable as it can be done reasonably accurately and rapidly, the actual determination taking little more than 5 min.

Tubers are grown in sterilized sand. When a test is to be carried out, the roots are carefully washed, and placed in tap water. Air is excluded by covering the water surface with a half-inch layer of liquid paraffin. The oxygen dissolved in a sample of the water is determined prior to the addition of the roots and again after 2 hr., when the roots are removed. Sometimes a second sample is taken after 4 hr. In these short periods the oxygen consumption of bacteria or other organisms, and the degenerative changes in the severed roots, will be slight. The dissolved oxygen determination is carried out by the Winkler method in the usual way[1]. The iodine, however, is determined with sufficient accuracy by means of a Lovibond comparator, the dissolved oxygen, in parts per 100,000, being obtained directly; but it is possible that further test may justify the use of the more accurate titration method for some purposes, such as the comparison of varieties of the British species.

If the volume of water containing the roots is increased, the reduction in oxygen concentration will be proportionately less; the converse will be the case for an increase in the amount of root. The volume of water or the actual mass of root is, therefore, immaterial, for the extent of the reduction in oxygen tension immediately indicates the amount of respiring root tissue per ml. of water. It was found that the gram or so of root generally available reduced the oxygen tension of 50 ml. of water appreciably; but smaller amounts of root and water have been used, and in one case the oxygen consumption of two 2-cm. lengths of root in 5 ml. of water was successfully measured with a syringe pipette[2]. Having determined the 'amount' of respiring root present, in terms of oxygen units, the water remaining after sampling is diluted to appropriate strength and used in hatching trials with a single-cyst technique[3]. Consideration of an actual test may serve to demonstrate the utility of the method.

A comparison of the South American species, *Solanum calcense*, and the British species, *S. tuberosum* var. Great Scot, was carried out with root excretions from tubers of similar size grown in sand. The initial oxygen tension of 1·0 parts per 100,000 was reduced to 0·6 by the British, and to 0·7 by the South American species, when the roots were removed 2 hr. later. The 'amount' of respiring root tissue per unit volume, using 'amount' for the combination of 'mass' and 'quality' concerned, was therefore greater in the former case. As the object of the experiment was to test the immunity of the South American species, the test was heavily weighted against immunity by diluting the solution from the British species twofold; the relative 'strengths', in the present sense, were now in the ratio of 2 : 3, that is, the solution from the South American was now 50 per cent stronger than that from the British species. Nevertheless the stronger solution stimulated fewer larvæ to emerge, the figures being 137 and 343 respectively, from 50 cysts; and the mean values for larvæ/cyst differed significantly. Without some method of standardization it would be impossible to say that this difference was not due to the activity of the material available; but while no finality is claimed for the figures, it is clear that in this experiment, from equivalent respiring root masses, either the South American species produced less root excretion of the same type as the British, or it produced root excretion of a different and far less effective type. It must be emphasized that the assumption on which the technique rests, namely, that the metabolic rate of root, as measured by its oxygen consumption under the somewhat abnormal conditions of the experiment, is necessarily related to the rate at which it produces root excretion, is by no means proved; however, the fact that potato root eelworm larvæ almost invariably enter the root immediately behind the growing point[4] suggests that this may indeed be so.

I am grateful to Drs. P. S. Hudson and J. G. Hawkes, of the Imperial Bureau of Plant Breeding and Genetics, Cambridge, for supplying me with the South American material for test.

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[1] "Standard Methods of Water Analysis" (6th Edit., New York, 1925).
[2] Fox, H. M., and Wingfield, C. A., *J. Exper. Biol.*, 15, 437 (1938).
[3] Ellenby, C., *Nature*, 152, 133 (1943).
[4] O'Brien, D. G., and Prentice, E. G., *Bull. W. Scot. Agric. Coll.*, No. 2 (1931).

## Æstivation among Terrestrial Isopoda

So far as I am aware, æstivation among the terrestrial Isopoda (woodlice) is unknown, and among the freshwater forms I know of only one example, that recorded by Mackin and Hubricht[1], who in writing on *Caecidotea spatulata* Mac. and Hubr. state, "When the ponds dry up at the beginning of summer, they burrow into the mud, construct a small cell in which they remain dormant until the pools again fill with water the following spring".

Recently, when cleaning some Petri dishes, I turned out of one a circular cake of soil ⅜ in. in thickness which, owing to its dry condition, broke into a number of pieces when laid on the bench. This particular dish had not been in use since May 10. From the broken soil two specimens of *Trichoniscus pusillus* Brandt were seen to creep slowly out. On more closely examining the pieces of the cake of soil, an empty space or cell could be distinctly made out, where these two specimens had lived for just over two months.

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[1] *Trans. Amer. Micro. Soc.*, 59, 393 (1940).

## Rotational Analysis of Ultra-Violet Bands of Silicon Monosulphide

SILICON monosulphide is a member of a group of diatomic oxides, sulphides, selenides and tellurides of carbon, silicon, germanium, tin and lead which has formed the subject of some recent spectroscopic investigations[1]. Its rotational constants are therefore of interest for comparison with other molecules of this group, and also for comparison with $P_2$, which possesses the same number of extra-nuclear electrons.

It was found some time ago[2,3] that a heavy-current positive-column discharge through the vapour of silicon monosulphide gave rise to a band-system in the region 2575–3875 A. The mode of production of this system in emission and the observation of a few of the stronger bands in absorption identified the carrier as SiS, and the values of the constants derived from the vibrational analysis suggested that the electronic transition involved was analogous to those responsible for the well-known ultra-violet systems of CS and SiO and the "Fourth Positive" ($A^1\Pi \rightleftharpoons X^1\Sigma$) system of CO. These observations on SiS have now been extended by a partial rotational analysis of the ultra-violet system.

The emission spectrum in the region 2800–3100 A. was photographed in a fourth order of the 10 ft.-concave grating at the Imperial College, London, the dispersion being about 1·28 A./mm. In spite of considerable overlapping and blending of the band lines, particularly near the origins, it has been possible to identify $P$, $R$ and $Q$ branches in the 0,1, 0,2, and 0,3 bands. Since the ground-state is almost certainly $^1\Sigma$, this indicates a $^1\Pi \rightarrow {}^1\Sigma$ transition, as expected. The values of the rotational constants obtained from these three bands are given below: they were derived from $\Delta_2F(J)$ differences involving only unblended lines and taking $D = 4B^3/\omega$.

| Band | $B''$ | $B'$ | |
|---|---|---|---|
| 0,1 | 0·3014 cm.$^{-1}$ | 0·2656 cm.$^{-1}$ | $B'_0$ (mean) = 0·2655. |
| 0,2 | 0·2998 | 0·2656 | |
| 0,3 | 0·2983 | 0·2654 | |

The ground-state constants can be expressed by the equation

$$B_v'' = 0{\cdot}3037 - 0{\cdot}0015_5(v'' + \tfrac{1}{2}),$$

so that $B_e'' = 0{\cdot}3037$. Although branches were followed beyond $J = 100$, effects due to $\Lambda$-type doubling of the $^1\Pi$ state were found to be smaller than the experimental error: this would be expected by analogy with the results[4] for SiO.

From the above value of $B_e''$, the value of the equilibrium internuclear distance is found to be 1·928 A. for $^{28}Si^{32}S$. This may be compared with the single-bond covalent distance as taken, for example, from the tables of Schomaker and Stevenson[5], namely, 2·15 A. The observed shortening of the length, 0·22 A., is evidence for a bond order

greater than unity and accords well with the values found for SiO (0·25 A.) and for GeO (0·15 A.)[1].

Finally, it is of interest to compare the spectroscopic data for SiS in its ground-state with those[6] for $P_2$, which has the same total number of extra-nuclear electrons ($n = 30$).

| | State | $\omega_e$ | $x_e\omega_e$ | $B_e$ | $r_e$ | $\alpha_e$ |
|---|---|---|---|---|---|---|
| SiS | $^1\Sigma$ | 749·5 | 2·56 | 0·3037 | 1·928 | $0{\cdot}0015_5$ |
| $P_2$ | $^1\Sigma$ | 780·4 | 2·80 | 0·3046 | 1·890 | 0·00165 |

The constants for the two molecules are seen to be remarkably close. The similarity in properties of the 14-electron molecules CO and $N_2$ has, however, been recognized for some time (for example, Kronig[7]), and examination of the data for the molecules with 22 electrons, CS, SiO and PN[1,6], reveals an analogous situation. Further, such data as are yet available suggest a close similarity in the properties of other sets of isoelectronic molecules belonging to these groups of the Periodic Table[1]. These relations can scarcely be fortuitous, but it is hoped to extend and perhaps confirm them by examination of other molecules of these groups.

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[1] Discussion on Band Spectra, *Proc. Phys. Soc.*, **56**, 204 (1944).
[2] Barrow, R. F., and Jevons, W., *Nature*, **141**, 833 (1938).
[3] Barrow, R. F., and Jevons, W., *Proc. Roy. Soc.*, A, **169**, 45 (1938).
[4] Saper, P. G., *Phys. Rev.*, **42**, 498 (1932).
[5] Schomaker, V., and Stevenson, D. P., *J. Amer. Chem. Soc.*, **63**, 37 (1941).
[6] Herzberg, G., "Molecular Spectra and Molecular Structure. I. Diatomic Molecules" (New York: Prentice-Hall, 1939.)
[7] Kronig, R. de L., "Optical Basis of the Theory of Valency" (Cambridge, 1935).

## Banded Meson Spectrum and the Rossi Second Maximum

CHANDRASHEKHAR AIYA[1] has recently reported the interesting result that there is a discontinuity in the meson absorption curve as measured by Bhabha's method, when the total lead thickness is about 21 cm. He suggests that this has been brought out because of the special arrangement of counters shown in his communication. Bhabha[2] has also mentioned that by his arrangement of splitting lead and placing it between a tray of anti-coincidence counters actuated by showers, it should be possible to study much more accurately the range spectrum of mesons.

Though Bhabha has not indicated where additional lead is to be placed in order to study the longer range mesons, it is clear that so long as there is lead at III (see Aiya's communication) below the anti-coincidence counters, the above view is incorrect and the method cannot furnish any new information about the range spectrum. The range of mesons measured is determined by the total lead thickness, and not only by the thickness of lead above the shower-detecting tray. Further, Aiya's procedure of placing lead on top in position I is open to objections from the point of view of determining the meson spectrum. In the first place the efficacy of the optimum thickness of lead in position II in order to produce the maximum number of showers is lost as soon as additional lead is placed in position I, and in effect the arrangement nullifies the basic idea put forward by Bhabha. Besides this, the net result of Aiya's procedure is to superimpose on the meson absorption curve a Rossi curve, to be subtracted by virtue of the anti-coincidence arrangement, which rather complicates the interpretation in regard to the range spectrum.

If one does want to get a more accurate measurement of the range spectrum of mesons by preventing the effect of the secondary particles that might be produced after the mesons are stopped, one should keep a tray of anti-coincidence counters actuated by showers right at the bottom of the lead. Or better still, in order also to avoid high-energy electrons, there should be another tray after a lead thickness from the top corresponding to the maximum of the Rossi curve.

If what Aiya gets has anything to do with a banded meson spectrum, one should get it at least equally well with a straightforward counter telescope without any anti-coincidence arrangement. It seems, however, more likely that the effect is related to the second maximum of the Rossi curve. The presence of lead below the shower-detecting tray has the effect of discriminating against electronic showers, and this is probably the reason why the fall in the absorption curve due to the second maximum showers is so abrupt. Further, the fact that the fall is maintained for greater thickness of lead tends to show that the maximum is flat. This point would indeed be more clearly demonstrated if fourfold coincidences 123(45) were measured to give directly the Rossi curve for hard showers.

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[1] Aiya, S. V. C., *Nature*, **153**, 375 (1944).
[2] Bhabha, *Proc. Ind. Acad. Sci.*, A, **19**, 23 (1944).

## Importance of Film Records

MR. OLIVER BELL, in *Nature* of August 12, suggests that the British Film Institute might "convene a Conference to obtain expressions of opinion" on the important question of the preservation and circulation of privately made films.

The Medical Committee of the Scientific Film Association has already issued a *questionnaire* to collect data about medical films with the view of raising funds to preserve those of value and, where necessary, adding titles or commentaries. It is hoped eventually to make arrangements for central distribution.

Although the first steps have been taken in the medical field, the Association is equally anxious to obtain information about all privately made scientific and technical films, and is already taking steps to send out a similar *questionnaire* to industrial firms and scientific institutions. It is also collecting information about all films suitable for technical training purposes with the view of the publication of catalogues and hand-lists of these films.

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# RESEARCH ITEMS

## Fishing Mortality and Effort

BARANOFF in 1918 formulated most of the present theory of the relation of the catch to rate of fishing, rate of natural mortality, of growth and of recruitment. His exposition, in the Russian language, was, however, somewhat inaccessible, and various other workers have discovered parts of the theory without knowing of Baranoff's work. William E. Ricker (*Copeia*, No. 1; 1944) has been back to Baranoff's paper, and has also corresponded with most of the other workers interested. He has now produced a clear and comprehensive development of the necessary definitions and equations. Formulæ are derived by which the expected catch can be calculated under different rates of fishing—given knowledge of the catch at one rate of fishing, and of the rates of natural mortality, of recruitment and of growth. Such calculations are necessary for advising immediately whether increase or decrease of fishing should take place, and Ricker's statement will therefore serve a practical purpose. He realizes, however, that no method exists at present by which one can extrapolate to determine the best rate of fishing, or the yield in any state very different from the one observed, unless Graham's approximation of 1935 is generally applicable—which remains to be seen. The difficulty in applying, in extrapolation, the kind of formulæ developed by Baranoff is that the rates of mortality, growth and recruitment are expected to vary with population density (growth-rate certainly does), and the law of their variation is not known. Graham's approximation assumes a simple law, which may be too crude; but it is regarded by Ricker as possibly the most interesting recent development in the theory of fishing.

## New Fishes

IN a series of notes in *Notulæ Naturæ* of the Academy of Natural Sciences of Philadelphia, Nos. 115, 117, 119 and 120, March–April 1943, Henry W. Fowler describes several fishes which are new to science. These include a goby from the Fiji Islands, a species of Poecilia from Honduras, two new characins from eastern Ecuador and some additional new fishes obtained from the second Bolivian Expedition from the Academy of Natural Sciences of Philadelphia 1936–37.

## Tegumental Glands in Cirripedes

C. M. YONGE's work on the tegumental glands in *Homarus vulgaris* has been extended to the Cirripedes by H. J. Thomas (*Quart. J. Micro. Sci.*, **84**; 1944). As in the Decapods, the exoskeleton consists of a chitinous layer secreted by the chitinogenous epithelium, and outside this a cuticle secreted by the tegumental glands. In correlation with the sessile habit of the Cirripedes, the structure of the animal as a whole and of the tegumental glands have undergone specialization. Unicellular and compound glands secrete the cuticle of the peduncle and of the capitulum, and that of the surface of the mantle cavity is secreted by the labial and subœsophageal glands. The latter are sometimes, but inaccurately, termed the salivary glands. In the Operculata the labial glands also constantly secrete a material which entangles the waste matter entering the mantle cavity and so facilitates its removal. Apart from this activity the glands secrete only at the moult. The cement with which the animal attaches itself to the substratum is of the same nature as the cuticle, and consequently the glands secreting it are to be regarded as tegumental glands. In the Operculata, the gland cells degenerate after secretion and new cells are developed from the wall of the duct.

## Structure of the Walls of Phloem Fibres

R. D. PRESTON (*Chronica Botanica*, 7, 414; 1943) points out that there is now considerable scope for the botanist, and especially the biophysicist, to make his contribution to the knowledge of the fine structure of the cellulose walls of plant cells. Owing to their commercial value, the fibres of the phloem (sclerenchyma) have so far been chiefly studied; in these the X-ray diagram indicates the presence of cellulose chains in the longitudinal direction only, while observations on swollen walls by optical methods have led to the view that at least two layers are present and that they differ in the direction of their cellulose chains. Crossed cellulose chains definitely occur in the walls of certain algæ. The X-ray diagrams of fibres of hemp and jute reveal the presence of cellulose chains in one direction only, running parallel with the major extinction plane; this diagram remains the same for fibres of different degrees of wall thickening, suggesting homogeneity of wall construction. However, by optical examination of swollen walls in cross-section, there is indication of heterogeneity, which does not appear to be accounted for entirely by differential distribution of lignin and pectin. Differential swelling of the wall in different regions leads to the production of striations of various kinds. Also the swollen material is easily broken into separate fibrils with associated change in direction of cellulose chains, which appears to have misled at least one worker. Swelling under certain conditions produces a 'ballooning' of the outer wall layer in hemp, but not in jute, and this fact, associated with observed optical phenomena, suggests that the outer layer in hemp and the inner in jute differ appreciably from the rest of the wall. It seems clear that in such walls the aggregates of the cellulose complex must differ in their association with one another in the different layers. Comparisons with long collenchyma cells suggests that the optical heterogeneity may be due to a variation in *angular dispersion* of the cellulose chains from layer to layer; this argument is less convincing for hemp and jute fibres, but not precluded by the X-ray diagram. There is therefore still doubt as to whether any chains exist in the secondary wall of these phloem fibres other than those which run in the longitudinal direction.

## Internal Discharges in Dielectrics

A PAPER on the observation and analysis of internal discharges in dielectrics was read in London recently before the Institution of Electrical Engineers by A. E. W. Austen and Miss W. Hackett. Discharges on the surface of, or in inclusions in, insulants, constitute a particular case of a large class of discontinuous phenomena common in electrical equipment. They are important as they are a form of partial breakdown and may afford evidence of incipient failure, while also they give rise to undesirable currents and voltages. The present paper is concerned chiefly with the former aspect. In cases of gross defect or deterioration of condition, surface discharges may

be the forerunners of complete spark-over. Internal discharges may be the immediate cause of breakdown due to local overheating, but their effects are more commonly cumulative, the most important probably being the carbonization of organic insulants, resulting in field distortion and spreading of defects. The paper refers to the various detector circuits employed for observing the discharges and discusses the probable characteristics of the latter. In dealing with applications of the methods, particular attention is given to impregnated-paper capacitors and to paper-insulated cables. The conclusions which the authors have drawn from the investigation are that the validity of discharge-detection methods is established, and that, of the methods of observation described, the discharge detector approaches the form likely to give the greatest sensitivity attainable by normal methods and is satisfactory for the purpose. The oscillograph bridge, though less sensitive, is more suitable for the measurement of discharges and is capable of yielding much information on their sources.

### Rapid Estimation of Sugar in Urine

J. E. STANLEY LEE (*Brit. Med. J.*, 847; June 24, 1944) describes an improved apparatus for the rapid estimation of sugar in the urine. This is adapted for use with Gerrard's cyano-cupric method, which depends on the power of the colourless double cyanide of copper and potash to hold cuprous oxide in solution. If Fehling's solution is titrated with a sugar solution in the presence of this cyanide, the blue colour gradually fades and there is no precipitate. The colourless end-point is therefore very sharp and, because there is no tendency to re-oxidation, the process can be carried out in an open flask. The apparatus, with its graduations, is illustrated, and directions for its use are given. The apparatus can also be used for estimation by Fehling's method.

### New Complex Compounds of Rhenium

STARTING with the double chlorides of rhenium and potassium, $K_2ReCl_6$ and $K_2ReCl_5$, two Russian investigators, V. V. Lebedinskij and B. N. Ivanov-Emin, have succeeded in preparing complexes with ethylene diamine in which rhenium occurs in the cation (*J. Gen. Chem. U.S.S.R.*, **13**, 253; 1943). At first they found that it was not possible to form complex rhenium compounds by the action of ammonia, pyridine or thiourea upon aqueous solutions of rhenichlorides. Anhydrous liquid ammonia reacted with the potassium rhenichlorides, but no stable amines could be isolated, whereas with excess of ethylene diamine on saturated rhenichloride solutions there was formed a new derivative of pentavalent rhenium having the formula $ReO_2(en)_2Cl$, where 'en' stands for ethylene diamine. This compound is soluble in water and does not form precipitates with anions except cobaltinitrite and platinichloride ions. A corresponding iodide, $ReO_2(en)_2I$, much less soluble than the chloride, was obtained from it by adding potassium iodide. With hydrochloric acid the rhenyl ethylene-diamine chloride gave a hydroxy-dichloride, $ReO(OH)(en)_2Cl_2$, which could be converted back into the monochloride by treatment with sodium hydroxide. This dichloride reacted with sodium platinichloride to yield a sparingly soluble complex rhenyl platinichloride, $ReO(OH)(en)_2PtCl_6$. With potassium iodide it gave the di-iodide, $ReO(OH)(en)_2I_2$. Excess of hydrochloric acid acted upon the original chloride derivative to form a further complex compound having the formula $Re(OH)_2(en)_2Cl_3$. These are the first reported instances of complexes with rhenium in the cation.

### Periodic and Asymptotic Orbits in a Five-Body Problem

DANIEL BUCHANAN, dean of the Faculty of Arts and Science, University of British Columbia, Vancouver, B.C., has discussed this topic (*Canadian J. Research*, Sect. A, Phys. Sci.; Jan. 1944). He considers four bodies of equal mass, which remain relatively fixed at the vertices of a square, while they revolve about their common centre of gravity with uniform angular velocity. An infinitesimal body is subject to the Newtonian attraction of the four finite bodies, and the problem is to determine the orbits in which it can move. A very full investigation of the subject is given, and periodic orbits in the plane of motion of the finite bodies and also cutting this plane, and in addition, asymptotic orbits within the above plane, are obtained for the infinitesimal body moving in the vicinity of its points of libration. Four diagrams show approximate orbits for different libration points, and among these are included the ellipse, parabola, a double loop and a figure-8 curve symmetrically situated with respect to the diagonal of the square of which the finite masses are the corners. The question of the convergence of the series arises because these solutions are power series in a parameter $\varepsilon$, $\varepsilon$ denoting the scale factor of the orbits. Regarding the periodic solutions, their convergence can be established by an existing proof in which use is made of Poincaré's extension to Cauchy's theorem "Les méthodes nouvelles de la mécanique céleste" (**1**, 338; 1892–99). This shows that periodic solutions exist and will converge for all values of the time, provided $\varepsilon$ is sufficiently small numerically. Alternatively, MacMillan's theorem (*Trans. Amer. Math. Soc.*, **13**, 146; 1913) can be used. The convergence of asymptotic solutions was treated by Poincaré (see ref. above) and the conditions which he established are fully satisfied for the asymptotic orbits that were constructed.

### Distribution of Intensity within the Solar Corona

H. A. BRÜCK has described the results of a photometric study of the inner corona, especially of the region extending from 2′ to 5′ from the solar limb (*Mon. Not. Roy. Astro. Soc.*, **104**, 1; 1944). The photograph of the corona which has been used was taken by the late Prof. H. F. Newall during the eclipse of August 30, 1905, and photographic densities within the corona were investigated with the Cambridge recording microphotometer. Records were made of the variation of density along 72 solar radii, beginning with the radius in the direction from the solar centre to the north pole of rotation and proceeding along radii with equal intervals of 5° in position angle. The intensity gradients, the method for deriving which is briefly described, show in the immediate vicinity of the sun a definite correlation with the structure of the corona. Along streamers or rays the intensity decreases less rapidly with increasing distance from the sun than in normal regions. No such correlation is indicated for the region extending from 5·6′ to 8·7′ from the solar limb. An effect opposite to that found by Brück for the inner corona was observed by von Klüber for streamers extending from about 6′ to about 70′ from the solar limb.

# BIOLOGICAL RESEARCH IN THE ARGENTINE

A NUMBER of reprints from *La Revista de la Facultad de Agronomía y Veterinaria*, 10, 111, November 1943 (Universidad de Buenos Aires; Facultad de Agronomía y Veterinaria) have recently been received.

F. Monrós has a paper with the title, "Algunos coleópteros de interés forestal observados en la Isla Victoria (Gobernación del Neuquen)". Observations conducted at the Victoria island of the National Park of Nahuel Huapi, during the months of January and February 1943, enabled the author to compile a list of Coleoptera which were detrimental to forest trees. A brief outline of the ecology of the island is given with the object of locating more easily the various species which are catalogued. About a dozen species are mentioned, and a list of the families found on the island is given, with the percentage of species corresponding to each one of these. Certain species which are abundant in other parts are not found on the island, and none of the Coleoptera on the island has been discovered in the surrounding regi ns. Aquatic or sub-aquatic Coleoptera were very seldom found, and terrestrial Micro-coleoptera were poorly represented. Some species fed on decayed organic matter, and a few others lived on the flora. Other interesting information is supplied by the author, who has made a very exhaustive examination of the Coleoptera on the island.

José Vallega has a paper with the title "Razas fisiológicas de 'Puccinia graminis avenae' halladas en la Argentina", which deals with the above pest found especially in the central and northern parts of the cereal region of the Argentine. Physiological races 3 and 7 were equally abundant and had the same geographical distribution. Experiments on resistance showed that, in general, oats cultivated in the Argentine and Uruguay were very susceptible to the two races of Puccinia, but among the foreign varieties the following were remarkable for their resistance: Richland, Rainbow, Iogold, Green Russian, Hawkeye, and a number of hybrids descended from them. In addition to the genus Avena, a number of grasses showed certain degrees of susceptibility; a list of these is given. The technique adopted for the investigation of the infection, powers of resistance, and various other matters relating to the investigation, were described in detail in a previous work published in 1940.

In a paper with the title "Observaciones sobre la biología floral de *Solanum chacoense* Bitter", Enrique L. Ratera describes the results of his investigations on this species during the years 1935–42. Research was conducted at the field station of the Institute of Genetics of the Faculty of Agriculture and Veterinary Science of the University of Buenos Aires, where the species, which is self-fertilizing, flowered and fruited abundantly. Diagrams show the appearance of the flower in the early morning and at other times; the positions adopted towards evening and during the night favour self-pollination; the anthers mature simultaneously with the receptivity of the stigma. From numerous observations it appears that the duration of the flowers of the species is about 4–5 days, at least in the place where the experiments were conducted.

Juan B. Marchionatto has a paper with the title "La obra fitopatológica de L. Hauman en la Argentina" which deals with Prof. Hauman's researches, especially those of which the results were published during 1907–25. His work started in 1904 in the Instituto Superior de Agronomía y Veterinaria de Buenos Aires, which became later the Facultad de Agronomía y Veterinaria. Hauman's first results were published in collaboration with Juan A. Devoto in 1908, and were a prelude to a more important publication six years later under the title "Les parasites végétaux des plantes cultivées en Argentine et dans les regions limitrophes". As a supplementary work, which was indispensable for teaching purposes, a collection of phytopathological specimens was prepared; and it was found that a solution of copper formate preserved the colour of the green organisms as well as the vegetable structure. The most important of his studies was connected with the mutations of certain organisms in vegetables, a task on which he laboured for several years and which resulted in showing that *Mucor stolonifer* Erb. was responsible for the production of decaying matter in the potato, although other fungi and certain bacilli were capable of producing similar results under experimental conditions. A very important paper was published in 1913 in *Ann. l'Inst. Pasteur* (A 27, 501), with the title "Contribution à l'étude des altérations microbiennes des organes charnus des plantes". The results of the investigation set forth in this paper were recognized as a serious contribution on the subject of parasites of plants and their action in the production of putrefaction. The paper deals with many other matters too numerous to mention, but a summary of Hauman's conclusions regarding the factors which favour or hinder parasitism in plants is as follows: (1) conditions which determine the abundance or scarcity in the environment of the organs of propagation of the parasites; (2) conditions more or less favourable in the medium for the development of the parasites; (3) conditions more or less favourable for the reception of, or resistance to, the host.

Jorge R. Christensen contributes a paper with the title "Estudio sobre el Género *Diabrotica* Chev. en la Argentina". The author has conducted very extensive research on the subject, and supplies a list of all the species which are pests of cultivated land, and in addition, has given indications of their hosts. The paper deals with the distribution and damage caused by the pest, its anatomy and external morphology, its life-cycle, and the method for combating it. Careful observation has shown that the most effective insecticide for dusting is rotenone, using a concentration of 0·5–1 per cent. Good results were also obtained by using 'Piretrina' in a 5 per cent concentration, but, on the whole, it was inferior to rotenone. In addition to a description of new species, there are also descriptions of species studied by other authors, and thirty-two illustrations at the end of the work.

A paper by Emilio F. Paulsen and Emilio S. Lio, with the title "Sobre el Contenido de arsénico en el tabaco", deals with the determination of the arsenical contents of smoking tobacco. The arsenic serves to combat certain pests, and the plant retains and absorbs a proportion of the insecticide, the amount depending on the nature of the preparation employed and also on the method of application. Considerable differences were found in the amount of arsenic present. Thus, in the case of the black cigarettes, 10–15 parts per million were found, while the contents for Virginian cigarettes fluctuated between

5·8 and 16·6 per million. In the natural tobacco on which no work had been expended before the tests were applied, the amount varied from 25 to 250 parts per million. The data refer to tobacco grown in the Argentine and worked up in its factories, with the exception of some specimens which contained mixtures of imported tobacco, and all the data refer to the types of cigars and cigarettes which find their way into the market. The danger of arsenic poisoning from tobacco is obviously very small.

## MAGNETO-STRICTION NOISE FROM TELEPHONE WIRES

WHEN magnetic material is subjected to a mechanical force, its magnetization is changed; and conversely, if its magnetization is changed, the material expands or contracts. There is thus a relationship between the stress and magnetization of magnetic materials which is called magneto-striction. According to an article by M. T. Dow (*Bell Lab. Rec.*, 22, No. 10; June 1944), noise encountered some eight years ago on certain telephone lines was found to be caused by vibrations set up by wind in a long river-crossing consisting of steel conductors, and experiments indicated clearly that the noise was due to magneto-striction. The alternating stresses in the taut wires vibrating under the influence of wind, resulted in corresponding changes in the magnetization of the steel wires, and these magnetic fluctuations induced voltages in the wires that appeared as noise at the ends of the line.

Since the voltages induced by magneto-striction vary at rates which depend on the rates of change of stress in the wire, the noise frequencies are related to the frequencies of vibration of the wire, and these in turn are determined largely by the size of the wire and the velocity of the wind; wire tension, span-length, and other such factors also have some effect. It was found that practically all frequencies of the magneto-striction noise were in the voice range, and under certain conditions the dominant frequency was in the neighbourhood of 1,000 cycles/second, which is the range producing the greatest disturbing effect. The test results confirmed a simple relationship expressed as $f = 7(v/d)$, where $f$ is the principal noise frequency in cycles/second, $v$ is the wind velocity in m.p.h., and $d$ is the diameter of the wire in inches. To produce a 1,000-cycle noise, therefore, the wind velocity is given by the expression $v = 143d$. Commonly used copper-steel wires are of 0·104 in. and 0·128 in. in diameter, and for these two sizes the wind velocities to give 1,000-cycle noise are about 15 and 18 m.p.h., respectively. These are velocities commonly encountered.

For the same velocity of wind, the greatest effect is experienced when the wind is approximately at right angles to the direction of the wires. Taut wires with sags of less than 8–10 in. in 130 ft. spans favour the generation of magneto-striction noise. Fairly steady winds with velocities around 20–35 m.p.h. produce the highest values of noise. Winds in this range of velocity favour the building up of resonance, which leads to high amplitudes, and also are likely to produce frequencies of the greatest disturbing effect. Turbulent winds, with velocities up to 64 m.p.h., seem to inhibit the building up of resonance, and thus are less effective in producing noise. The effect is greatest in all-steel wires, and becomes less the greater the relative amount of copper.

An estimate based on a study of the results obtained indicates that for tight wires, in an exposure of 25 miles or more in length where conditions favour magneto-striction noise, the unamplified noise generated during windy periods would probably average around 28 db. above reference noise. Occasionally, maxima might reach as high as 36 db. above reference noise. Both these figures are for tight, copper-clad wire of 40 per cent conductivity; the corresponding figures for wire of 30 per cent conductivity would be about 3 db. higher. Under similar conditions, the noise for all-steel wire is likely to be 10–25 db. higher. Actually, while magneto-striction noise has been experienced with steel wire, none has ever been reported on circuits employing copper-clad wire.

## USE OF 'POLAROID' FOR THE MICROSCOPE

By DR. A. F. HALLIMOND
Geological Survey of Great Britain

FILMS of very strongly pleochroic material, usually mounted between glass plates, have been available during the past few years under the trade-name 'Polaroid'. For some purposes they can replace the nicol prism, but their use has been restricted because in a moderately strong light they transmit a noticeable reddish-violet colour at the position of extinction.

Disks of improved 'Polaroid' of high optical quality have since been made, and a British firm of instrument makers recently placed two of them at the disposal of H.M. Geological Survey for investigation of their possible use in the petrological microscope. The following is a brief report, communicated by permission of the Director, Geological Survey and Museum, on their properties, which rival those of the best nicol prisms.

*Extinction.* It has been understood that 'Polaroid' was prepared by the alignment of small pleochroic crystals in an artificial preparation. Consequently one might expect that the extinction would be less sharp than that for a nicol prism, and that a small proportion of the strongly absorbed ray would still be transmitted. For the pair of disks now to be described both these fears proved groundless.

Fig. 1 shows two examples from several curves that were measured by means of a visual microphotometer, similar in purpose to that of M. Berek, which I hope to describe shortly. One nicol (or 'Polaroid') was fixed in the usual position in the microscope, while the other was placed on the rotating stage, which could be read to 0·1°. Stray light was excluded by means of black paper tubes. With a strong beam it was possible to obtain a variation of 100 units on the photometer scale within a rotation of $\pm 2°$ from extinction. Curve $A$ is the ordinary extinction curve for two nicol prisms; there is good agreement between the photometer readings (shown by circles) and the continuous curve calculated from the usual formula, indicating that the photometer scale is practically linear. The readings along curve $B$ were obtained with two 'Polaroids'; they again show substantial agreement with the corresponding calculated curve, even for the range nearest extinction.

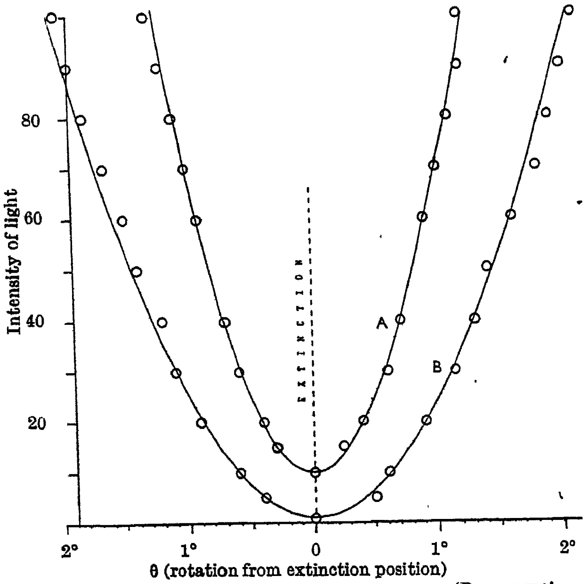


Fig. 1. Extinction curves for nicol prisms and 'Polaroids'. O, Photometer readings; full curves calculated from $\sin^2\theta$.

The intensity at extinction is not seriously different from that indicated by the curve drawn through the other readings. This curve was fully confirmed by a repetition with rather more residual light, so that the readings were from 10 units upward on the photometer scale. If the calculated curve is extrapolated to give the approximate photometer reading when the nicols (or 'Polaroids') are parallel, the percentage of residual light at the extinction position can be obtained; it is very low, being 0·0052 per cent for curve *A* and 0·0015 per cent for *B*. It follows that the absorption of the strongly absorbed ray in this 'Polaroid' is practically complete. When the sun or a lamp filament was examined directly through the crossed 'Polaroid' disks, the transmitted beam had a lilac colour, but in front of a microscope lamp it was too weak to be distinguished.

The residual light seen at extinction in the microscope, whether with nicols or 'Polaroids', is almost completely polarized by the analyser; it is thus to be assigned chiefly to the diffusion of light at the surfaces (or the admission of stray light) between the polarizer and the analyser. This is readily tested by examining the field at extinction through an additional nicol; light transmitted owing to the inadequacy of the analyser itself would be polarized at right angles to the above. The low value of the residual light in curve *B* is due to the relative ease with which the 'Polaroids' can be enclosed, and the small number of surfaces; it gives satisfactory evidence of the absence of cloudiness in the 'Polaroid' itself.

*Definition.* The 'Polaroid' disks can be made optically flat. When one was inserted in a microscope instead of the analysing nicol, the lateral displacement of the image was inappreciable and there was no apparent loss of definition. The slight displacement of focus due to the thickness of the glass was also practically negligible; if necessary, it could be completely compensated by placing a blank glass in the space usually left vacant.

*Absorption of light.* 'Polaroid' has a neutral smoky tint; measurement by the visual photometer showed a transmission of 32 per cent for green light, and later measurements gave 34 for green and 36·5 for a 'tricolour red' screen. In order to obtain a more complete determination of the absorption for the visible spectrum, the 'Polaroid' was submitted to Dr. J. McClelland at the Government Laboratory, and the following report is communicated by permission of the Government Chemist.

"The 'Polaroid' plate was fixed in front of the slit of a constant deviation glass spectrograph at right angles to a beam of light from a tungsten lamp, and rotated so as to transmit the maximum amount of light. Photographs were taken by the usual method, with exposures adjusted to give approximate equality of the spectra with and without the 'Polaroid'; the intensity of the images was then compared photometrically in a Hilger non-recording microphotometer over a series of wave-lengths. The results, one of which is represented in Fig. 2, are remarkably uniform, with a slight increase in absorption in the blue-green; otherwise there is no evidence of any noteworthy absorption band, even toward the limit of the visible spectrum."

These results imply the substantial absence of colour in the light transmitted by the 'Polaroid'. The small differences in the spectrum fall within those commonly found in the various 'daylight' screens and other sources usually employed. Of the incident light, approximately 50 per cent is completely absorbed by the polarizing action, as in the case of the nicol prism. The transmitted beam, which in a nicol would approach 50 per cent (with a small deduction for loss at the surfaces employed), is 33 per cent in the 'Polaroid', so that there is a loss of about 1/3 in the transmitted light with one 'Polaroid' and about 1/2 with two. In practice this difference seems to be more than compensated by the greater diameter at which the condenser can work when 'Polaroid' is used instead of a nicol, by the elimination of compensating lenses and by the improved extinction that may be obtained. In any event, for transmitted light there is no difficulty in using a rather stronger source. For the ore microscope the light-source is nearer the practicable limit and the aperture is often limited on other grounds; nevertheless 'Polaroid' would seem likely to be useful for all but the most exacting work on bireflexion, and for this also if a sufficient source is available.

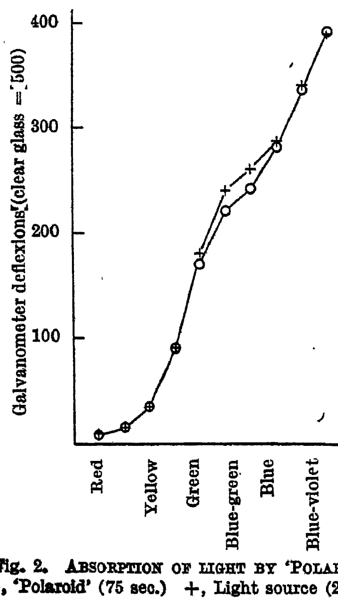


Fig. 2. Absorption of light by 'Polaroid'. O, 'Polaroid' (75 sec.) +, Light source (25 sec.)

From the preceding brief account, it would seem that the new 'Polaroid' is likely to require most serious consideration not only for students' use but also for research microscopes. Not only is there a substantial saving in cost if the material can be supplied at a similar price to the nicol prism or lower, but improvements are also possible in the optical system and in the microscope design.

## THE MELLON INSTITUTE

### WAR-TIME RESEARCH

UNDER the title "The Mellon Institute in the Second Year of War", a brief summary of the activities of the Mellon Institute has been condensed from the thirty-first annual report, indicating its contribution to the war effort. During the year, March 1, 1943–March 1, 1944, a multiple industrial fellowship on chain welding and metallurgy was divided into two separate fellowships on chain welding and on powder metallurgy techniques. The iodine fellowship was revived in April, and seven other proposals for research have been accepted. The Institute's industrial research staff now consists of 201 fellows and 214 fellowship assistants. Two of these fellowships have been active for thirty years, seven for twenty-five and eight for twenty; sixty in all have concluded at least five years of research. During the year the Institute's expenditure for pure and applied research amounted to 1,652,539 dollars. A new fellowship for research in the wood-container field is concerned to improve standards and production practices for shipping containers and also to eliminate the enormous amount of wood waste in the conversion of trees to such containers of finished lumber. A fellowship has been established to improve cotton fibres by altering the chemical structure without loss of identity or workability of the fibres, and another fellowship will conduct broad basic studies of the physical and chemical properties of cotton. A new fellowship of the Copperas Co. is devoted to studies of the oxidation products of major aromatics from tars.

Nine fellowships were completed during the year; they covered air-pollution control, anti-icing, garments, naphthalene chemistry, pasteurization, pencil technology, surgical supplies, synthetic rubber and tar treatment. Work on air-pollution control was brought to a temporary end through the death of the incumbent fellow. A report has been published on studies under the synthetic rubber fellowship of the toxicity of butadiene carried out for the Rubber Reserve Co.

The Institute's Department of Research in Pure Chemistry directed its efforts chiefly towards chemotherapy. Results obtained with certain new drugs as antimalarial agents are sufficiently encouraging to warrant further research. Under a scheme promoted by the National Research Council, arrangements have been made for evaluating the anti-malarial activity of new drugs. More than eighty new drugs have been submitted for antimalarial appraisal, and efforts have been directed towards possible ways of diminishing the toxicity of chemical structures recognized as possessing anti-malarial potentialities. Investigations on problems in the preparation of cinchona alkaloid derivatives with anti-pneumococcal potency have been terminated and the results published. Prototypes of a new class of modified cinchona derivative in which the phenolic hydroxyl group of apocupreine is replaced by an alkylamino constituent have been prepared by the Bucherer reaction, but the therapeutic action was not increased. A method has been evolved for the preparation of *p*-toluenesulphonyl esters of phenols and alcohols rapidly, economically and in high yield. A publication from the Department and the Department of Chemistry of the University of Pittsburgh deals with *cis*-3 : 6-endomethylene-Δ-4-tetrahydrophthalic acid: the anhydride of the corresponding hexahydrophthalic acid has been obtained quantitatively by direct catalytic hydrogenation under high pressure. The synthesis of 3-benzoyl-nor-camphane-2-carboxylic acid by a Friedel-Crafts reaction has been worked out.

Referring to researches proceeding in the Institute under the industrial fellowships, the report states that friction losses in vaned elbows of asbestos ducts have been determined in numerous designs; and the physical and chemical treatment of gypsum, which has received very thorough investigation during the past five years, has yielded especially valuable results in 1942–43. There are eight fellowships in all in the field of ceramics. Thirteen fellowships have been concerned with metallurgical studies and the failure of restrained welds; and the destructive testing of structural joints, involving special gaskets, has received much attention. Systems have been developed for centralized filtration of machine-tool coolants and a differential solubility process for treating waste pickle-liquor is announced. A research programme on the hydrogenation, dehydrogenation, oxidation and alkylation of coal products has been widened considerably, and several new catalytic processes are under development. A new process for ethylbenzene has been put into operation on the large scale, and another investigation has been concerned with the effect of paraffins on the nitration of toluene.

In addition to basic research on the production of phenols, another group is working on the separation of cresols and xylenols from their mixtures; new naphthalene derivatives are also receiving much attention. Studies of the rheological properties of bituminous materials have been continued, and substantial progress has been made in improving fractional distillation techniques under extremely high vacuum.

Under the seven fellowships pertaining to major problems of the food industry, improvements have been effected in dehydrating prepared foods, and new knowledge has been gleaned on decolorizing absorbents, including the evolution of a new synthetic granular absorbent for the sugar industry. In the textile field, the weathering of treated fabrics used as covers over the guns of coastal defences has been investigated to secure textiles more resistant to sun, salt air, wind and rain, and new yarns have been prepared from soya bean protein alone and with viscose, as well as a synthetic textile lubricant for the woollen industry. Reference is also made to advances in processing animal fibres used in felt and the co-relation of physical properties with felt quality. *GR-S* latex has been applied commercially to the saturation of sulphite papers, with results indicating a satisfactory comparability with rubber latex-treated papers but with somewhat less tensile strength. Growing attention to cyclopentadiene has greatly stimulated research on methods for its utilization. Compounds of interest for the manu-

facture of synthetic resins, rubbers and fibres have been prepared electrolytically and a new curable liner for container closures. New techniques have been developed for the preparation of vinyl resin coating compositions, and a thorough investigation made of the production, purification and analysis of butadiene and styrene by the multiple industrial fellowship on tar synthetics. Other studies have been concerned with specifications for metals for the construction of butadiene and styrene plant. Fundamental work has also been done on the physical chemistry of the purification of raw materials for synthetic rubber. The polymerization of butadiene, styrene and acrylonitrile are under close scrutiny, and new tests for the adhesive properties and ageing characteristics of paints and for the rheological properties of elastomeric adhesives have been adopted as guides in the development of new adhesives, while several new formulæ for 'Cellophane'-tape adhesives have been derived.

Other fellowships have been concerned with protective coatings. Several papers were published on the basic aspects of anti-fouling paint performance. Exhaustive studies of a possible accelerated corrosion effect from accidental or deliberate contact of steel hulls with the anti-fouling paint have indicated that appreciable acceleration can occur under the usual type of anti-fouling compositions containing heavy metals. The production of alkylene polyamines is being delineated precisely for industrial applications, and promising products for the synthesis of motor fuel, for the preparation of chemicals for synthetic rubber and as ingredients for lubricants, paints and insecticides have been developed from investigations on nickel compounds and catalysts. An insecticide which has given a 98 per cent kill of houseflies in the Peet-Grady chamber has been developed. Several new organic iodine compounds have been prepared in a search for improved iodine antiseptics. Work on intermediates for sulpha drugs has kept pace with current advances in this field.

Studies on the toxicity of several new products and of materials the health hazards of which were unknown but all used by the military forces or government contractors, such as dioctyl phthalate, low-temperature and extreme-pressure lubricants, insect repellents and cable-impregnating compounds have been completed.

Special reference is made to the work of the Industrial Hygiene Foundation, a non-profit association of industries for the maintenance and advancement of healthy working conditions, which has its headquarters and a multiple fellowship at the Mellon Institute. This Foundation has continued its investigation of sickness absenteeism commenced in 1941. It has given some attention to the placing of disabled soldiers who are returning to the United States and has conducted some fifty plant hygiene surveys, including exposures to such substances as synthetic resin dust, trichloroethylene, hydrogen fluoride, carbon tetrachloride, and excessive temperatures. The Foundation has continued to support medical investigations at the Saranac, New York, Laboratory under L. U. Gardner, covering disability through silica compounds and the effect of aluminium therapy. A grant was also made by the Foundation during the year for a plant investigation of health problems of women in industry. Publications on health problems of women in industry as well as on putting the disabled soldier back to work have been issued during the year.

# FORTHCOMING EVENTS

## Tuesday, September 19

INSTITUTE OF PHYSICS (ELECTRONICS GROUP) (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5.30 p.m.—Dr. A. Sommer: "Principles of Photo-Electric Emission and their Application in Photo-Electric Cells".

## Wednesday, September 20

INSTITUTE OF METALS (at the James Watt Memorial Institute, Great Charles Street, Birmingham), at 2.15 p.m.—Thirty-sixth Annual Autumn Meeting. Discussion on "Melting and Casting of Bronze".

PHYSICAL SOCIETY (COLOUR GROUP) (at the Lighting Service Bureau, E.L.M.A., 2 Savoy Hill, Strand, London, W.C.2), at 3.30 p.m.—Mr. H. G. W. Harding: "Illuminants for Colorimetry and the Colours of Total Radiators".

## Friday, September 22

INSTITUTION OF NAVAL ARCHITECTS (joint meeting with the INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND) (at 39 Elmbank Crescent, Glasgow), at 2 p.m.—Dr. J. Foster King: "Longitudinal Bending Moments"; Dr. J. Tutin: "Methods of Levying Charges for Services to Shipping"; Mr. B. Alwyn Jay: "Timber in Shipbuilding".

## Saturday, September 23

BRITISH PSYCHOLOGICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 2.30 p.m.—Prof. J. C. Flugel: "Psychological Aspects of Moral and Social Progress" (Papers in comment by Dr. Karl Mannheim and Dr. R. H. Thouless).

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

RESPONSIBLE LECTURER IN PHYSIOLOGY—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3 (September 20).

RESEARCH ASSISTANTS (2) IN PHYSICAL CHEMISTRY (Low Temperature Polymerization)—The Registrar, The University, Manchester 13 (September 20).

ASSISTANT LECTURER (temporary) IN MATHEMATICS—The Secretary and Registrar, The University, Bristol (September 20).

RESEARCH ASSISTANT (male, temporary) in the Agricultural Entomology Division of the Ministry of Agriculture of Northern Ireland—The Assistant Secretary (Establishments), Ministry of Finance, Stormont, Belfast (September 21).

BIOCHEMIST (Reference No. F.2841.A), and a PHYSICAL CHEMIST (Reference No. F.2842.A.) at the Cereals Research Station, St. Albans—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting the appropriate Reference No.) (September 23).

TEACHER OF MATHEMATICS in the Newton Heath Technical School—The Director of Education, Education Offices, Deansgate, Manchester 3 (September 25).

QUALIFIED CIVIL OR MECHANICAL ENGINEER to teach Mechanical and Constructional Drawing—The Director of Education, The Polytechnic, Regent Street, London, W.1 (September 25).

CIVIL ENGINEER for the duties of Assistant Divisional Engineer by the Sudan Government Irrigation Department—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.1114.A) (September 25).

TEACHER (full-time, graduate) OF ENGINEERING for Day and Evening Classes in the Crewe Technical College—The Director of Education, County Education Offices, City Road, Chester (September 26).

ELECTRICAL ENGINEER for the Nigerian Government Public Works Department—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.926.A) (September 26).

FIRST-CLASS ENGINEER to assist in Steam Turbine Design, Research and Development (location, Midlands)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2166.XA) (September 26).

CHAIR OF MINING—The Acting Registrar, The University, Leeds 2 (September 30).

DIRECTOR OF RESEARCH, Forest Products Research Laboratory, Princes Risborough—The Secretary, Department of Scientific and Industrial Research, Teddington, Middx. (October 9).

ASSISTANT TECHNICAL EXAMINING OFFICERS (temporary) in the Victualling Department of the Admiralty—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2911.A) (October 11).

LECTURER IN PHILOSOPHY—The Very Rev. the Dean, Christ Church, Oxford (October 15).

ELDER PROFESSORSHIP OF ANATOMY AND HISTOLOGY in the University of Adelaide—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (October 31).

DIRECTOR OF THE DEPARTMENT OF SOCIAL STUDIES, University of Sydney—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (Sydney, December 1).

READER IN STATISTICS who will also act as Director of the Institute of Statistics—The Registrar, University of Oxford, Old Clarendon Building, Oxford.

ASSISTANT MECHANICAL ENGINEER for the Electrical Branch of the Nigerian Government Public Works Department—The Secretary, Overseas Manpower Committee, Ministry of Labour and National Service, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. 1391).

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CONTENTS




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## SCIENTIFIC AND INDUSTRIAL RESEARCH.—V

IN our survey of the strategy of research we have already noted that, in addition to their functions in training the research workers required by the nation, the universities have an essential place in the organization for research, especially in regard to fundamental research. We have still to consider the tactics by which the fullest use can be made of the universities in this organization without detriment to the highest traditions and ideals of the universities, either in teaching or in the intellectual and spiritual service of the community. Furthermore, in considering the broad objectives towards which our programmes of research should be directed we have seen the need for some co-ordinating authority in our research structure, competent to review the broad programmes, to assess their importance and relevance to national needs and to determine the gaps which may require filling or the sectors which may require strengthening, either from the point of view of scientific advance or of the needs of society.

We come now, therefore, to a fuller consideration of the type of organization which is required to serve our strategy and the tactical modifications or developments which may be desirable in the existing structure to fulfil our purposes more effectively. That existing structure has received strong criticism in recent months, and it is appropriate in the first place to consider that criticism in fuller detail. In the main such criticism has been concerned with the lack of co-ordination particularly with reference to the planning of research, as was pressed in the House of Lords debate last year and again in the debate on research and scientific knowledge in the House of Commons last April. Dr. P. Dunsheath urged in his Atkinson Memorial Lecture that industrial research requires a live central co-ordinating secretariat. That was also the main reason for the London Chamber of Commerce proposing, in its report on scientific industrial research, the establishment of a strong central research board to act as a co-ordinating and directing body for all research organizations and to be the link between the Government and the research activities of the country at large.

That criticism is also reflected in the statement of the Association of Scientific Workers, "A Post-War Policy for Science". The survey of the organization of science contained in this statement leads to four main comments. First, the latest developments in our war-time organization have not in many fields satisfactorily linked research to requirements. Secondly, lack of central direction has produced a lack of balance in the development of science, as shown by the entirely disproportionate lack of development of biology as compared with the physical sciences. Third, the same cause, and the practice of private industry, lead to unnecessary and wasteful use of scientific effort. Finally, the whole scale and scope of research appears to be inadequate to supply the country's needs after the War.

Some of these points are made also in the severe

criticism of the existing structure to be found in an article, "Research, Intelligence and Administration", by Prof. Harold J. Laski in a series of articles on "Post-War Machinery of Government" in *The Political Quarterly*. Prof. Laski argues that there is little co-ordination, no effective machinery for publicity, and no real attempt to integrate the work and needs of government departments with those of outside bodies. All major scientific institutions—the Royal Society, the Royal Institution, the university laboratories, the British Association—depend on private benefactions for their main opportunities.

Of the sixteen points in which Prof. Laski finds the present organization defective, some are clearly matters of tactics rather than organization, though they may be due partly to bad organization—for example, the inadequacy of the salaries and status of Government research workers. Mostly their relevance in this connexion is clear enough, and without necessarily accepting their validity they may be briefly summarized as follows.

The funds at the disposal of research are utterly inadequate. The pattern of administrative organization is awkward, lacking in integration and defective in comprehensiveness. The relation of research to administration is gravely defective, and the control of research is mostly in the hands of men with no serious acquaintance with the possibilities of either natural or social sciences. There is no properly thought out policy for long-term research or any planned attempt to use the universities or bodies like the Royal Society to conduct independent investigations into problems with which the community is concerned.

No proper method exists in any government department for securing awareness of relevant work achieved by scientific workers in foreign countries—a defect which is specially marked with regard to the U.S.S.R. The present system also sacrifices the endowment of research to the easy method of direct subsidy to industry, indicating a tendency to the short-term in place of the long-term view, which in such fields as nutrition is clearly detrimental to the national interest.

Relations between the Government and the social and natural sciences are in Prof. Laski's view dominated by the theological inheritance of our society and by the individualistic approach. Again, he takes exception to the age of those who are charged with the direction of these relations and he also points to the dangers in the implications of the relation between the administrator and industry in the existing system. Finally, he comments on the inherent inertia or desire of departments to let well alone, and on the slight opportunity for the research worker in the natural or social sciences to show his powers as an administrator save by accident: all the vital places are in effect reserved for the administrative grades of the Service.

Now that is a formidable list, and the gravamen of the indictment is increased by the fact that most of the criticisms are substantiated by comments in Parliamentary debates and in the numerous reports and papers on scientific and industrial research from different sources which have appeared during the last year or so. Prof. Laski's thought, however, is very clearly coloured by his political approach, as is evident from the nature of his observations on the major changes that are required. Furthermore, his preoccupation with the political—and it might be argued the party—aspect of the problem has led him to ignore the merits or advantages of the present system, and the principles which our consideration of the strategy and objectives of research has already led us to postulate.

Prof. Laski's conclusion indicates that he is concerned more with a political thesis than to elucidate the form of organization which will best serve the principles and objectives which have been adumbrated in our survey of the strategy of research. The validity of his particular criticisms may be admitted and measures must be adopted to guard against their effects in whatever type of organization of research may be set up. The nature of that organization, however, should not be dictated primarily by political considerations but by the requirements of research and the principles which in practice have best secured its effective implementation, even though the time may be ripe for impartial re-examination of the whole question of the structure of industry from the point of view of social and economic efficiency and research.

That is the main reason why, in spite of widespread recognition of many of the defects in the present organization, there has been little evidence of a demand for fundamental change. Prof. A. E. Trueman in his pamphlet "Science and the Future", for example, examines the situation far more objectively than Prof. Laski, and concludes that, so far as the planning of science is possible, it can suitably be achieved within the organization already available. The existing organization is loose and flexible, but provides a sound basis for extending a working combination of Government assistance and direction with the help of voluntary workers. While it makes possible a general control, it leaves a large measure of individual liberty, and in particular the intellectual and professional freedom which is vital.

The development or modification of existing institutions which within their respective spheres are effective is so in accordance with the tradition of British methods that strong reasons should be forthcoming before we proceed to discard them entirely and replace them by fresh instruments. No such reasons are forthcoming in Prof. Laski's criticism, which, it will be noted, is in the main of the administrative side. Much of it, moreover, is in keeping with the essential point in the criticism of the machinery of government to be found in the reports of the Select Committee on National Expenditure, in the *Planning* Broadsheets and in the earlier report of the Haldane Committee: we need effective machinery for the planning and co-ordination of general policy. In research as elsewhere, our organization must provide, in the words of the Haldane report, "for the organised acquisition of facts and information, and for the systematic application of thought, as

preliminary to the settlement of policy and its subsequent administration".

If a modified or developed organization meets this requirement we shall have met the main points of Prof. Laski's criticism, in so far as that is properly relevant to organization and is not concerned either with the quality or ability of administrative personnel or with the financing or endowment of research. There are, however, other and even more vital considerations to be taken into account before deciding on what form our structure of research should take, or what modifications may be required in the existing organization. Further, there are certain special problems at the present time which must be handled by that organization and for which new instruments may be required.

First, it follows from what we have already said regarding the precedence of personnel over organization, that our organization for research must be such that not merely does it secure the most effective use of research workers in furtherance of our research objectives, but also it maintains the enthusiasm and initiative and originality which are vital factors in creative work.

To keep the administrative side imaginatively alive to such issues and sensitive to trends of opinion may well involve further attention to the question of intelligence as part of our research structure, but that aspect can be more profitably considered with reference to the broader question of education and information in relation to the utilization and support of research. This question of freedom in relation to organization and planning is also of vital importance in considering some of those problems in the organization of research which are specially prominent at the present time, particularly in regard to the place of the universities. As has been pointed out in a recent article in *The Economist*, all the evidence points to a growing dependence of our universities upon State assistance as compared with fees or private and independent endowments.

That circumstance of itself would demand extra vigilance to ensure that there is no weakening of the independence of the universities and of the essential freedom of inquiry and of teaching. The desirability, if not the necessity, of relating the universities more intimately with the research effort of the country as a whole so as to facilitate the planning of that effort more effectively, and the obvious importance of some further measure of co-operation between the universities themselves so as to secure the adequate endowment and staffing of whatever additional schools of research or teaching may be required while avoiding redundancy, also compel consideration of new measures of reorganization from much the same point of view.

These are the reasons that have led to some attention being redirected to the constitution and functions of the University Grants Committee. That Committee, Mr. Attlee stated, has recently been reconstituted so as to permit the association with it of persons whose services are not actively engaged in connexion with a university. In the opinion of some, such as Sir Charles Grant Robertson, such a reinforced Committee should be able to sift the programme of development of each university and to analyse and value the needs not only of each institution but also of university education as a whole. It should probably also be competent to co-ordinate special departments so that there will not be avoidable duplication or overlapping, and a single university may be selected to be the institution where a particular subject can be most efficiently pursued.

That opinion is not universally shared. The British Association Committee has suggested that the University Grants Committee might function as a Committee of the Privy Council instead of, as at present, directly under the Treasury, but its report also proposed the establishment of a universities' advisory council, entirely free from Government control. That was also the proposal of the Parliamentary and Scientific Committee and of the Association of University Teachers, and has received some support in the more recent report, "Science in the Universities", issued by the Association of Scientific Workers. While, however, the Association of University Teachers visualizes the proposed council as possessing advisory functions only, some means of providing more effective central control appears to be required, as the Parliamentary and Scientific Committee and the Association of Scientific Workers clearly recognize.

The Association of Scientific Workers contemplates that the power of such sub-committees would be limited to advising when and where new departments were needed for the investigation of newly opened fields of knowledge. The University Grants Committee would normally act on their advice and provide funds accordingly, and the research committee which it is proposed each university should establish to watch over departmental activities and present a total research budget to the university for transmission to the University Grants Committee would also maintain contact with such sub-committees. This scheme would avoid rigid planning and divorce the direction of research activities from the Treasury, but it does not appear to provide a means of dealing effectively with the problem of present redundancy to which Sir Ernest Simon has so pointedly directed attention.

We may postulate, therefore, that in regard to the universities our organization for research must provide some effective means for consultation and cooperation between the universities themselves, whether through the development of the University Grants Committee, through a universities advisory council or in other ways. Next, it must establish right relations between the universities and public bodies in which the universities recognize that they are in large part public institutions with public duties to perform, in providing the education and producing the graduates the country requires. The means provided for both these purposes must safeguard the independence of the universities and of the fullest freedom of investigation and teaching while securing responsiveness to the creative forces at work in the nation as a whole.

In this question of contact between the universities and the community in the organization and planning of research, contact with industry is of special importance. We have stressed the importance of such contacts from the point of view of personnel, but more organized contacts are required from the point of view of the planning of research itself. That is the significance of the Joint Council set up by the University of Manchester and the Manchester Chamber of Commerce.

Looking at the sphere of research for which the Government may be held directly and primarily responsible, it has long been recognized that the work required to maintain accurate standards of length, time, weight, etc., is properly a Government responsibility. Research in such sciences as astronomy and geology also requires a large measure of Government security. Similarly, it is right that such specialized forms of industrial research as factory lighting and ventilation, and on industrial safety should be carried on largely under Government auspices and financed out of public funds. Much the same applies to research into questions of soil erosion, forestry, plant diseases, water supply and many other problems in the domain of agriculture or health which have a social as well as an economic bearing.

It is, of course, not easy to draw precise limits as to the extent of Government responsibilities. Already a number of Government research stations, such as those concerned with building, fuel, food, agriculture, are in effect carrying out industrial research, but generally speaking it may be said that this applies to industries which are fundamental to the life and well-being of the nation. It is to be expected that the Government will always have a special interest in the industries serving these fundamental needs, and that there should be adequate provision of research into such problems under Government auspices, especially when the industries concerned are not easily able to organize such research themselves.

From this point of view the Department of Scientific and Industrial Research has unquestionably proved its value and should be retained in our structure of research. But over a far wider field the Government should be constantly on watch for new developments in scientific knowledge which may be of economic or social value to the nation. It was very noticeable in the House of Commons debate last April that research into medical and health problems, even where they closely affect economic productivity, was largely overlooked. Nor was anything said of economic and social research, and particularly the use of scientific methods in the study of relations between human beings.

It is clear that even from the point of view of the organization of research under direct Government auspices some means of ensuring a wider view and of effectively correlating the work of the Advisory Council for Scientific and Industrial Research, the Medical Research Council, the Agricultural Research Council and the Colonial Research Council is essential, and this must cover also the whole social and economic field and provide the Government with the best impartial scientific advice on all matters of industrial development on the application of scientific knowledge. Obviously such an organization capable of supplying the necessary central direction must be related to the Cabinet and to the policy-making bodies of the various sections of the Government if it is to be aware of the national problems concerned.

These could well be the essential functions of the Scientific Advisory Committee of the War Cabinet, and Dr. Haden Guest's proposal that this should form a permanent part of our machinery of Government might in principle meet the need, though its terms of reference as set forth in the White Paper on Scientific Research and Development must be enlarged and the details will require elaboration. The Association of Scientific Workers has suggested the establishment of a National Research and Development Council responsible to the Lord President of the Privy Council. The suggestion of a Ministry of Science is unlikely to be as satisfactory for reasons which were well stated by Mr. Attlee in a reply to Mr. Wootton-Davies in the debate. Co-ordination is not the same as centralization, and it is important to retain as much flexibility as possible in our organization and to aim at the permeation of all Departments of State with some understanding and appreciation of the scientific method and outlook.

When we have thus provided for the effective organization of research in the universities and under direct Government auspices there will remain a large field of applied research to be undertaken by private industry. It must be recognized that here there can be no question of formal organization from outside, any more than there can be such organization of fundamental research at the universities. In the discussions on industrial research during the last two years, while it has been clearly recognized that the Government has certain responsibilities in this field and that neglect of research has been an important factor in the depressed condition of some industries, with consequences in the national economy which no Government can wisely ignore, there has been no suggestion that the Government should do more than provide the most favourable conditions for stimulating research, whether in its fiscal and taxation policy and by the allowances made for obsolescence or by its attention to the supply of scientific workers through an adequate policy of scientific education. The essential function is that of encouragement, and the Nuffield College statement firmly rejects the idea of direct financial aid to the research expenditure of private firms, beyond what may be granted in the form of tax remissions.

One reason for rejecting any such proposal is that no such concession would be made on general lines without extending public control over the research thus aided, and such control over industrial research in the direction of the discovery of new products and new processes or on the improvement and simplification of existing processes and the discovery of new raw materials would probably be both unwelcome and impracticable. None the less, industrial research must be included within the general framework of the nation's organization for research, partly because of this recognized responsibility of the Government

for encouraging such research in appropriate ways, partly also because of the State's responsibility for seeing that the field is adequately covered, and partly for the reason that the invaluable interchange of personnel between pure and applied research and the contacts which are so stimulating cannot be secured without some regard on the part of the State to the general conditions of industrial research.

There is another reason for some closer consideration of applied or industrial research by the State. We have already seen that in certain industries fundamental to the national welfare the Government has already in its own research stations assumed direct responsibility for much of the research required. Suggestions have also been made that there is need in Great Britain for institutions of the type of the Mellon Institute of Industrial Research or the Massachusetts Institute of Technology to provide either an organization in which research workers can be delegated to study specific industrial problems or to cover problems which are common to many industries but the concern of none in particular, as, for example, chemical engineering.

The problem is well put in the Nuffield College statement, but that statement makes no recommendation that public funds should be applied to this purpose. Clearly any such project must be carefully examined from the point of view of existing research stations or research associations and their development, and also in regard to developments at the universities. No decision on such a point could well be reached except at the level of such a Scientific Advisory Committee as we have already adumbrated.

The place of the research associations demands a little further attention. Doubts have frequently been expressed as to the extent of their effectiveness, but in view of the number of small units in many industries and the growing cost of equipment, co-operative research of this type must probably find a more or less permanent place in our research organization. Large laboratories may be required for research both of the convergent or divergent type, and it may also be advantageous for some of the smaller industries to attach themselves to research institutions maintained by larger industries which are technically related to them. Moreover, consideration must also be given to the question of the extent to which the research associations themselves would be responsible for some of the fundamental research required, thus supplementing that in progress at the universities.

The assistance or encouragement which the State may be expected to give to industrial research will thus vary with the nature of the industry and with the size of the constituent firms. It is thus imperative that our organization should be flexible and that the Government policy should be as fully informed as possible—a further and fundamental reason for a co-ordinating secretariat and information centre for industrial research. No scientific advisory council can function effectively unless it is provided with adequate and efficient fact-finding instruments upon which its policy can be based.

# FOSSILS AND ROCK CHRONOLOGY

## Index Fossils of North America

A New Work based on the complete revision and re-illustration of Grabau and Shimer's "North American Index Fossils". By Prof. Hervey W. Shimer and Prof. Robert R. Shrock. Pp. ix + 837 (303 plates). (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1944.) 20 dollars.

A CENTURY and a quarter have passed since William Smith's "Strata Identified by Organized Fossils" (1816–19), with its figures of some 160 British fossils, made the long-delayed announcement of the discovery indicated in its title. The subsequent correlation of sedimentary rocks throughout the world has largely depended on the application of this discovery. Included microfossils now often enable the oil geologist to ascertain the horizon of the smallest sample from one of his borings; coal seams may be identified by fossil shells in the associated shales. In such ways has the study of fossils become of great practical help to mankind.

There is no doubt, however, that the field geologist is now very diffident about attempting to deal personally with any fossils he may collect, so extensive is the literature and so intricate are modern schemes of classification. The work under review is a notable attempt to remove such difficulties by presenting an epitome of modern knowledge of American invertebrate palæontology. Although nominally a revised edition of Grabau and Shimer's "North American Index Fossils" (1909–10) it contains so much new matter that it may well claim to rank as a distinct work. Many leading American palæontologists have collaborated in its preparation.

An index fossil, we are informed in the introduction, is "one which identifies and dates the strata or succession of strata in which it lies", but since ideal index *species*—forms with restricted stratigraphical range and broad geographical distribution—are comparatively rare, "a *genus* which has narrow stratigraphic range and rather broad geographic distribution is now considered an index fossil". Notwithstanding its title, however, the work is by no means restricted to genera of limited range, for "some genera with long vertical ranges have been selected, not because of any particular value as index fossils but because they are common", and it has, moreover, "been thought proper to give some representatives of each of the main taxonomic groups which may be encountered in the field".

The primary object of the work is thus to serve as a guide to the identification of genera, although it will enable many species, some of use as stratigraphical indexes, to be named incidentally. By its aid it should be found possible to ascertain to what formation any assemblage of American fossils should be referred, but in subdivided formations it is no guide to the very precise horizon. Detailed zonal work, such as has been carried out at many horizons of the stratigraphical sequence by the intensive study of such groups as the graptolites of the Lower Palæozoic and the ammonites of the Mesozoic, receives no mention. The inclusion of a glossary or table of formational terms adopted in the work would have been useful, for most non-American (and probably many American) readers will probably be as ignorant of the positions of such formations as

the "Kinzers", "Hosselkus", "Steamboat", and "Pinecrest" as is the reviewer.

Grabau and Shimer's work consisted of two volumes totalling 1,762 pages; its successor contains more subject-matter, but consists of a single volume of 837 pages. The reduction, probably enforced by war-time paper restrictions, has been accomplished by the adoption of a larger format and more closely spaced type (in double columns), and by the grouping of all illustrations in plates. Considerable additions have been partly provided for by the omission of artificial keys to genera and species (such keys seldom prove of much use to the palæontologist), by the curtailment of specific descriptions, and by the omission of chapters of a general character. Owing to their comparatively insignificant type, names of orders and suborders unfortunately appear subordinate to the generic names. The illustrations, 9,400 in number, occupy no fewer than 303 plates, and their general standard is excellent. Their profusion, even if it has meant the sacrifice of a certain amount of text, is amply justified. In no other work will the palæontologist find assembled a series of figures illustrating so many genera of all groups. The figures are partly new and partly reproduced from standard monographs.

The search for oil in many parts of the world during recent years has given an impetus to the study of many groups of organisms, particularly those of microscopic size, the value of which as stratigraphical indexes was formerly unsuspected. The Foraminifera are a case in point. In the much enlarged section dealing with this group J. A. Cushman describes the smaller forms, L. G. Henbest the Fusulinidæ of the Upper Palæozoic, and W. S. Cole the Orbitoids of the Upper Cretaceous and Tertiary. In other new sections E. B. Branson and M. G. Mehl deal with the Conodonts and a group of specialists with the Ostracods. Although fossil plants as a whole do not fall within the scope of the work, a concluding chapter contains notes on a few such remains, particularly Charophyta, likely to be found in rock samples searched for other microfossils.

Far-reaching changes in classification must always present a problem to writers of reference books. Kiderlen's inclusion of the Conularida in the Cœlenterate class Scyphozoa, although far from convincing, is accepted, but the important work of Kozlowski on the affinities of the Graptolitoidea (which he transfers from the Cœlenterata to the class Pterobranchia of the Hemichorda) is ignored, as is also Withers's separation of Turrilepas and its allies from the Cirripedia as a new group, the Machæridia.

A new section on the Crinoidea, the work of R. C. Moore and L. R. Laudon, is one of the outstanding features of the work; particularly notable are its clear line-drawings illustrating generic morphology. G. A. Cooper's section on the Brachiopoda, also new, deals mainly with the Palæozoic genera, those of the Mesozoic receiving scant mention. The section on the Pelecypoda has been curtailed with only slight revision. Some genera (for example, Ptychomya) of real value as index fossils are now omitted. Much more might have been said about the stratigraphical value of the Rudists (of importance in Texas and Mexico) and of certain groups of Trigonia. Among the genotypes cited that of Anthracomya ("*Naiadites elongata* Dawson") is incorrect, that of Pecten ("*P. adscensionis* Osbeck") very debatable, and that of Janira ("*J. niternudia*" [? *intermedia*]) hopelessly misprinted. Revision of the Gastropoda section has mainly affected the Palæozoic forms, dealt with by J. Brookes Knight. The section on the Trilobita, in which several authorities have collaborated, gives descriptions and figures of a large number of new genera founded in recent years.

The high price of the work no doubt results from the profuseness with which it is illustrated. European palæontologists will find it most valuable for reference notwithstanding its purely American scope.

L. R. COX.

# THE CONSEQUENCES OF FRUSTRATION

## Frustration and Aggression

By John Dollard, Neal E. Miller, Leonard W. Doob, O. H. Mowrer and Robert R. Sears, in collaboration with Clellan S. Ford, Carl Iver Hovland and Richard T. Sollenberger. (International Library of Sociology and Social Reconstruction.) Pp. ix+150. (London: Kegan Paul and Co., Ltd., 1944.) 10*s*. 6*d*. net.

EIGHT members of the Yale Institute of Human Relations have co-operated to produce this book. The result is not a mere juxtaposition of uncoordinated viewpoints but a unity of aim and consistency in presentation which make the multiple authorship almost undetectable. Whatever judgment one may make about the value of the hypothesis elaborated in the book, there can be little doubt that the intimate collaboration of a team of specialists, each with a distinctive training, is a profitable way of examining a problem which has no clear-cut frontiers and which does not fall neatly into one of the conventional compartments of social study.

The authors begin by indicating the many diverse forms of aggressive behaviour ungeneralized under any one explanatory principle, and to meet this apparent need they set up a twofold hypothesis, first, that frustration always leads to aggression and, secondly, that aggression is always due to frustration. They proceed then to show how the theory provides one conceptual framework for a variety of human phenomena including the process of socialization in infancy and childhood, the adjustments necessitated in adolescence, criminal behaviour, the effects of differences in political organization and the structure of a primitive society.

The frustration-aggression hypothesis, in one form or another, is not new. This is recognized by the authors, who attempt to go farther than earlier theorists by giving special prominence to what they regard as the inevitable consequence of frustration on one hand and the sole cause of aggression on the other and then scrutinizing the explanatory value over a wide field of a hypothesis stressing this two-way relation.

Apparently, it was considered less important for the purpose to examine the validity of the assumptions underlying the hypothesis than to deduce corollaries which follow from it. Since the hypothesis is presented not with any finality, but tentatively, to stimulate and guide further research, this attitude can be justified. Nevertheless, the effect will be to make many readers regard the book as an exercise in deductive rather than inductive reasoning without giving them sufficient confidence in the inductive foundations on which it is based.

To make premature deductions from a generalization insecurely founded inductively leads to difficulties. Thus, on the principle that aggression is a catharsis that reduces instigation to all other acts of aggression, together with the principle of displacement, it is deduced that various forms of aggressiveness should vary inversely if original frustration is held constant. One has difficulty in reconciling this with the continued aggression in many directions of aggressor nations whose original frustration has presumably remained unchanged. Aggressive acts frequently seem to have a way of reinforcing the instigation to other such acts rather than to operate in inverse relation to them.

Until fairly recently the belief that aggression is determined by a primary instinct was widely accepted. This instinct was regarded as existing, as it were, in its own biological right and manifesting itself, so to speak, autonomously. Thanks to a growing understanding of the nature–nurture issue, aggressiveness is now thought of more as an acquired characteristic rather than as an inborn tendency. The authors' view that all aggressive behaviour is due to the impact of the environment upon the individual may therefore be welcomed in that, as a theory, it is subject to verification and tries first to exhaust the possibilities of explaining in terms of known before resorting to unknown categories.

However, certain objections to the traditional theory of aggressiveness as an innate tendency still hold against the theory under consideration. For these objections were usually based on the observed variability of behaviour in different environments, inexplicable genetically, and not in accord with a conception of mind as a rigid set of predetermined dispositions. The present hypothesis retains this element of rigidity although it abandons the notion of innate aggressiveness. Now while there is doubtless some relation between frustration and aggression, many may wonder whether it is justifiable to lay it down even as a hypothesis that frustration *always* leads to aggression. Such a theory implies an essential biological connexion holding between the two processes. But may not the relationship be culturally rather than biologically determined ? If so, it is an 'accidental' rather than a necessary association. Before this possibility can be wholly excluded, it needs to be demonstrated that no individual can respond to frustration unaggressively such as would seem to be the case, for example, in maternal conduct in general or possibly in 'turning the other cheek' or in masochistic behaviour. The eagerness to find a 'law of Nature' has evidently tempted the investigators to presume, too hastily, the existence of a necessary relationship. Since perfect interdependence of two variables rarely, if ever, seems to be encountered in human measurement, this alone would suffice to cast doubt on the validity of the hypothesis as it stands.

There is yet another difficulty. According to the view put forward, frustration and aggression appear to be opposite ends of one continuous event or experience with an arbitrary line of division between them, for if the relationship between the two processes is invariant, who is to say when the experience of frustration terminates and the impulse of aggressiveness begins ? It is doubtful whether anything is gained by defining aggression 'independently' of frustration and whether it is logically justifiable to do so.

The limited scope of the hypothesis is brought out most, perhaps, in the relatively little light it throws upon the most obvious and important kind of aggressive behaviour of all, namely, collective aggression or warfare. An early promise (p. 19) of the authors to bring "wife-beating and war" within a common universe of discourse appears to be overlooked in subsequent pages. The only serious reference to the subject is the familiar observation (p. 64) that in view of the process of displacement of aggression from in-group to out-group, "one, though only one, of the conditions of avoiding war is to diminish intra-social frustration". It may be noted in passing that there are weighty considerations against any view which sees in a group phenomenon like modern warfare merely a summation of the effects of the frustrations of individuals. For that matter, it is exceedingly doubtful whether individual frustration or, indeed, any process of individual behaviour as such, can be given any primary significance in explaining an organized group phenomenon like modern war.

The authors' treatment of criminality calls for a few words of comment. They regard the incidence of crime as a function of the discrepancy between frustration, on one hand, and anticipation of punishment on the other. If both these factors are of high or if both are of low degree, or if the former is low and the latter is high, then crimes will tend to be few ; if, however, frustration is high and anticipation of punishment is low, then crimes will tend to be many. The difficulty here, as indeed with the subject as a whole, is to find some measuring scale for the basic variables. What is a unit of aggression or of frustration ? Can we ever say that one person is twice as frustrated or twice as aggressive as another ? This difficulty is fundamental and lies at the root of mental measurement. So long as the investigator is content with statistical units or abstract frames of reference for classifying human behaviour, the difficulty can be evaded even if the results are psychologically not very satisfying. But the authors here are more ambitious. They wish to find a few common psychological denominators under which to embrace all the diverse phenomena of crime. They try to do this in an indirect way which is not very convincing. Crime is assumed to be a species of aggression simply because it is supposed to be a response to frustration. This supposition is, in turn, based on correlations between the incidence of crime and economic, vocational and educational status, intelligence, age, health, physical appearance and other factors. To use these latter observations and their interpretation as evidence of the frustration–aggression hypothesis is to beg the question. Moreover, a large proportion of crimes such as larceny or offences against property without violence do not fall under the authors' definition of aggression as "an act whose goal-response is injury to an organism (or organism surrogate)".

The fact that the divorced population provide a disproportionate number of convicted persons is regarded by the authors as "the most dramatic demonstration of all of the role of frustration in the causation of criminality" (p. 91), the assumption being that divorce is usually a frustrating event. It seems to be overlooked that divorced persons are a selected and possibly maladjusted group and, hence, whatever factors lead to the break-up of their marriages may also contribute to their increased criminality.

While feeling that the main hypothesis has not been adequately formulated, the reader will be amply rewarded by the many illuminating remarks scattered

through the pages, particularly in Chapters 4 and 5. One example may be mentioned. The authors point out that the cathartic effect of aggressiveness which follows frustration serves only to reduce the secondary instigation produced by frustration not, as is commonly assumed, the strength of the primary instigation which suffered frustration.

The frustration–aggression hypothesis, even with limited scope, is not simply of academic interest. All those charged with the care and upbringing of children, with the management of personnel in the various spheres of industrial and social life are frequently confronted by individuals in their charge who react in a hostile manner to unavoidable frustrations. This clear discussion of the problems of adjustment which individuals must face in any society should be of much practical value. Further verification of the theoretical basis will be welcomed.

JOHN COHEN.

## BERKELEY'S PHILOSOPHICAL NOTES

### Philosophical Commentaries, generally called the Commonplace Book

By George Berkeley, Bishop of Cloyne. An editio diplomatica transcribed and edited with Introduction and Notes by Prof. A. A. Luce. Pp. xlii+486. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1944.) 73*s*. 6*d*. net.

THE manuscript generally, but inaptly, called "Berkeley's Commonplace Book" is a document of unique interest in philosophical literature. Berkeley took his B.A. at Trinity College, Dublin, in 1704 at the age of nineteen. In 1709 and 1710 he published his "New Theory of Vision" and his "Principles of Human Knowledge", the two works on which his philosophical fame has always rested. Berkeley's ideas were novel, but very clear and articulate, and skilfully argued in these books. The only thinkers to compare with him, who advanced so far so quickly, are Descartes and Hume. It is most fortunate that we can examine the notebook in which he recorded his philosophical reflexions during this short period of intense mental activity. Prof. Luce considers that the notes were written during 1707–8, and that Berkeley probably had before him a preliminary draft of his theories. Thus the "Commonplace Book" shows how his first thoughts were altered and improved until they attained their first published form, never greatly altered alterwards.

The manuscript was discovered by Campbell Fraser and published in 1871 in his edition of Berkeley's works. Unfortunately, Fraser failed to notice that the two notebooks Berkeley used had been bound together in the wrong order, so that his text is confusing. G. A. Johnston's edition of 1930 corrects the principal error in chronological order. Prof. Luce, however, finds that Johnston has still got some entries misplaced. There are also other inaccuracies in the two earlier texts. Moreover, the original document was damaged by sea water when Berkeley had it with him on his travels. Parts were difficult to decipher in Fraser's day and are now much worse. Prof. Luce has therefore undertaken to produce a complete type-facsimile of all the entries of philosophical interest, with erasures, alterations and later remarks all in place. In addition he has provided copious and very necessary notes, cross-references and indexes. The value of these can be seen by taking an example at random. Entry No. 526 reads: "Locke says the modes of simple Ideas besides extension and number are counted by degrees. I deny there are any modes or degrees of simple Ideas. What he terms such are complex Ideas as I have prov'd by Green". This is cryptic enough. However, given the correct reference to Locke, to several other entries in the "Commonplace Book" and to Berkeley's published work, we can then see how Locke's tentative, stumbling but very suggestive analysis of perceptual processes stimulated Berkeley's more precise mind; how Berkeley gradually clarified his own thinking and terminology to produce a different, far more definite (perhaps more erroneous) statement. Prof. Luce provides a guide to these interconnexions that will save readers much hard work and many misunderstandings.

Students of Berkeley for many generations to come will be grateful to Prof. Luce for this fine piece of work, to his publishers and printers who have shown that good craftsmanship is still possible after nearly five years of total war, and to Trinity College, where Berkeley's thinking was fostered and where his memory is still honoured as it should be.

A. D. RITCHIE.

## AN ASTRONOMICAL TEXT-BOOK

### Elementary Mathematical Astronomy

By C. W. C. Barlow and Dr. G. H. Bryan. Fifth edition, revised by Sir Harold Spencer Jones. Pp. viii+388. (London: University Tutorial Press, Ltd., 1944.) 12*s*. 6*d*.

THIS book belongs to the peculiar class intermediate between the popular work on astronomy on one hand and the serious technical treatise on the other. The scope of the class is otherwise not easily defined in precise terms. Sir Robert Ball, who made a distinctly elegant contribution to it, confessed that the effort had caused him great and apparently unexpected difficulty. Simon Newcomb, whose work on the popular side had been as conspicuously successful as his labours in mathematical astronomy were of the most distinguished, once ventured into a similar field belonging to neither. In acknowledging frankly an error brought to his notice he showed him self-conscious of a pitfall to which the expert is liable in the attempt to make a statement adapted to the intelligence of readers less gifted than his usual audience.

Neither of the two original authors of the present text-book belonged to the ranks of the professional astronomer. That it possessed merits of a distinct kind is attested by the fact that it has outlived half a century, during which it has reached a fifth edition, while the number of impressions demanded has been far more numerous. The third edition (1923) received the revision of Dr. A. C. D. Crommelin. But it may be suspected that the survival of the book is due in no small degree to the English mania for examinations and the demand fostered thereby. It has now received a fresh lease of life at the hands of a most eminent editor who has done his work well. Yet there remain traces of that aridity which is a natural outcome of its origin. It may be hoped that when war-time restrictions are removed an editor so eminently qualified will see his way to expound the subject with greater freedom in his own manner.

In 1892, when the book first appeared, astronomy seemed to have reached a peculiarly static position, in reality the unsuspected precursor of an outburst of creative activity. In particular, the Nautical Almanac seemed to have attained a settled form unlikely to be changed for years to come, and with it the outlook of the student was bounded accordingly. Now the conditions have changed, including the definition of time; the Nautical Almanac itself is not the same, and it has been supplemented by the abridged edition for the use of seamen and the Air Almanac for the special needs of air navigation. Moreover, the students are not the same; their interests are professional and no longer merely academic. Thus the opportunities which face the instructor in astronomy are vastly more interesting than existed half a century ago, and they are different in kind.

The more spectacular modern changes in the subject-matter of astronomy itself may seem to be associated with the introduction of physical methods and ideas. But the Astronomer Royal has confined his revision to bringing up to date the exposition of those fundamental principles on which the whole subject depends, to rearranging related sections and to providing a sound introduction to the methods of sea and air navigation now in use. An enlarged table of astronomical constants has been added. But in the main the substance of the work remains as in earlier editions. In abstaining from incursions into astronomical physics the editor is doubtless justified by the proved success of an existing model. Even without transgressing the limited ideas of the nineteenth century some relief to the purely goniometric line of argument might be found in the conception of radial velocity and in the rectangular co-ordinates appropriate to photographic projections. Without going so far the Astronomer Royal has greatly improved the structure of the work and made many necessary alterations within its familiar framework. But if in happier days a fresh edition is contemplated, one is tempted with all respect to exclaim with Hamlet, "O! reform it altogether". In short, let it be a new work inspired with the aim of serving as the master, not the servant, of the examiner. H. C. PLUMMER.

## CHEMISTRY OF WHEAT

**The Constituents of Wheat and Wheat Products**
By Prof. C. H. Bailey. (American Chemical Society Monograph Series, No. 96.) Pp. 332. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1944.) 6.50 dollars.

THE object of reviewing a book is to give readers some information on the author and his authority for writing on the particular subject, to indicate the scope of the book and to give an impartial evaluation of the value of the work. This is not a particularly difficult task in this case.

C. H. Bailey, professor of agricultural biochemistry in the University of Minnesota, is one of the foremost cereal chemists in the world. His work, often with a band of devoted students and postgraduate workers, is well known to all workers in that field. His contributions, both in quantity and quality, to cereal chemistry probably exceed those of any other worker. He was awarded the highest honour that can perhaps be given to a cereal chemist, namely, the Osborne Medal of the American Society of Cereal Chemists, in 1932. He has practical experience of book-writing in that he published in 1925 a book entitled "The Chemistry of Wheat Flour", which was No. 26 of the Monograph Series of the American Chemical Society, of which the present book is No. 96. Nobody, therefore, is better fitted to undertake the task of collecting together in book form the known facts on the constituents of wheat and its products. With characteristic painstaking thoroughness, Prof. Bailey has for years been working on a card index system to collect the necessary facts for the present book.

The book has a definitely restricted scope. It does not deal with the processing of wheat and its products, the chemistry of such processing such as the changes which occur in milling and bleaching, or in the making of bread or confectionery goods. It is hinted in the preface that a further book dealing with these and allied matters may be issued later. So far as it is possible to make such an arbitrary division, the present book is concerned with exactly what the title states, namely, the nature of the various constituents, such as the proteins in wheat and its products, the character of the starch, sugars, gums, lipids, minerals, pigments, etc., present, and particularly the vitamins which are now known to exist in the various portions of the grain. The vitamin chapter is typical of the whole book in that it gives a comprehensive account of practically all the important work which has been done, especially the recent work. What will be particularly appreciated is the fact that this chapter covers not only $B_1$ and its distribution in the grain, but also all the known facts with respect to the presence of riboflavin, nicotinic acid, pyridoxine, pantothenic acid and other vitamins in the whole grain, in various types of flour and in offal, including germ.

The book comprises sixteen chapters. Practically the first half, namely, up to p. 139, is concerned with the protein and other nitrogenous constituents. This part is particularly full, but contains much of the earlier work, now known to be of little value but which is presumably retained as of historical interest and to give the background for the more recent work. The book is not intended as a textbook for the various industries concerned. There is little general discussion and it consists essentially of a record of published scientific investigations. It will therefore be of particular value to future research workers. The book is well balanced and there are relatively few omissions to work that matters. The comprehensiveness of the book, although only of 332 pages, is seen from the fact that there are approximately eight hundred names in the authors' index, and the references to published papers approach 2,000. The book appears to be singularly free from errors and misprints, although it was observed that in Table 112 the last column should presumably have been mgm. per 100 gm. and not mgm. per lb. Incidentally, the variety of ways in which vitamin results are recorded, such as μgm./gm., mgm./100 gm., mgm./lb., etc., are always confusing, and it is convenient to have the relationship table given on p. 282 of the book.

The book not only fulfils a real want but also fulfils that want well. There is a scarcity of good books on the chemistry of wheat and its products, and this is true of any language. We have no hesitation in recommending this book to all advanced workers in this field—in fact, they cannot afford to be without it. D. W. KENT-JONES.

## Endocrine Man

A Study in the Surgery of Sex. By Dr. L. R. Broster. Pp. xi+144. (London: William Heinemann (Medical Books), Ltd., 1944.) 12*s.* 6*d.* net.

IT is impossible to review this book in the space available. It is full of ideas, records of experimental work and stimulating discussion. Every page of it counts. The author is a surgeon at the Charing Cross Hospital, and his broad thesis is a discussion of the origin and evolution of what he calls the instinctive tripod, namely, self-preservation, growth and sex, all of which are classified as instincts. The chapter leading to his discussion of instinct is a remarkable summing up of the development of animals. Like the final chapter on the nature of man, it reveals the author's wide knowledge and outlook.

The chapters on the evolution of species, on the physiology of the autonomic nervous system and on the functional evolution of the endocrine system are no less valuable. The last-named chapter introduces the author's study of virilism, feminism, intersexuality and other more obscure conditions due to disorders of the adrenal, the pituitary and the genital glands, which he has been conducting with his collaborators at the Charing Cross Hospital for the last fifteen years. The book reveals some of the remarkable results which have been achieved by the surgical treatment of these disorders and discusses their biological significance. The quality and trend of this discussion may be gathered from the author's suggestion, based upon his experience and clinical observation, that, whatever the genetic (chromosomal) constitution may be, this may be overridden by hormonal influences.

In his last chapter the author suggests that slight adaptations resulting from nervous and endocrine control (he has already discussed the interplay between hormones and the functions of the brain) could be "inscribed in the framework of the germ cells". This view visualizes the vital role of the endocrine system in the integration of development and also suggests that "variable factors may be introduced into the germ plasm through its hormones to account for influences which, on the whole, have consistently led to the progress of mankind". Sir Peter Chalmers Mitchell contributes an interesting foreword and there is a valuable bibliography. Everyone will hope that the work of this team, interrupted by surgical war service, will be resumed as soon as possible.

G. LAPAGE.

## Human Reproduction and Venereal Disease

By Dr. John Drew. Pp. 124. (London: Faber and Faber, Ltd., 1944.) 3*s.* 6*d.* net.

THIS layman's guide to the venereal diseases is wider in scope than the title suggests. It covers human anatomy, the venereal diseases and their treatment, their relation to sterility and their sociological implications. The descriptions of diseases are accurate, but as the author has gone to so much trouble to give the medical terms for the lesions he describes it would have been wiser to avoid all possibility of misinterpretation in the case of "condylomata" and have called them "condylomata lata". Many people have condylomata but only some are also syphilitic. Some purists might quibble at the guides to pronunciation given for treponema (treppon-nee-mar) and gumma (gum-mar).

A book for laymen is scarcely the place to indulge in discussions about criteria of cure in syphilis. Even if biological cure cannot be attained, clinical cure is possible in nearly every case of early syphilis if the patient will co-operate, and this is all that it is necessary to say. A more hopeful note could have been sounded on the length of treatment for syphilis in these days when intensive treatment is widely used and penicillin is just over the horizon.

## Sheffield Burns

By Dr. W. H. Hatfield. Pp. 213. (Sheffield: J. W. Northend, Ltd., 1943.) 7*s.* 6*d.*

SHORTLY before his unexpected death, Dr. Hatfield, whose name is closely associated with the development of special steels, had completed some reflexions on people and things, inspired by the sight of the great conflagration in Sheffield during the air raids of 1940. Dr. Hatfield was a devoted son of Sheffield, and his aim in writing was to help in its restoration. The little book contains reminiscences of the author's contacts with scientific men and other notable people at home and abroad, brief accounts of visits to industrial centres in other countries, and expressions of personal opinion on matters of public interest. His views on economic questions, based on experience in large-scale industry, lean strongly to the side of private enterprise, while his remarks on scientific and industrial research and its organization gain weight from his own marked success in stimulating co-operative research in the iron and steel industry, and from his earnest advocacy of a similar policy for industry in general. Any profits from the sale of the little book are to be devoted to St. Dunstan's.

## The Statesman's Year Book

Statistical and Historical Annual of the States of the World for the Year 1944. Edited by Dr. M. Epstein. Eighty-first annual publication, revised after Official Returns. Pp. xxxvii+1484. (London: Macmillan and Co., Ltd., 1944.) 30*s.* net.

IN spite of current difficulties, the new issue of this valuable reference volume maintains its scope and size. Revision of statistics has been difficult and for many States impossible, but the latest available are given. For many parts of the British Commonwealth and the United States figures are of a recent year. The section on the armed forces of the United States has been extended. Other additions include a short account of the British Council and its aims, the Middle East Supply Centre, and, under Australia, an account of the Australian Capital Territory. The introductory tables of comparative production of various commodities have had to be omitted, but there is still a section on the League of Nations. A coloured map shows the extent and boundaries of Poland at various periods in the history of that State. The useful book-lists for each State have been fully revised.

## Brompton Hospital Reports

A Collection of Papers recently published from the Hospital. Vol. 12, 1943. Pp. vii+163. (London: Brompton Hospital, 1944.) 8*s.* net.

THE papers in this volume are reprints of recent work by members of the Brompton Hospital staff. Most are concerned with diseases of the chest. In an interesting statistical survey on "The Health of the Doctor", Dr. A. Hope Gosse challenges the title of 'the doctor's disease' often given to coronary thrombosis.

# METEORITES OR SPRINGS AS GEOLOGICAL AGENTS?

By DR. E. B. BAILEY, F.R.S.
Geological Survey of Great Britain

DOUGLAS JOHNSON'S recent death is mourned by a wide circle of friends and admirers on both sides of the Atlantic. Johnson delighted in interpretation of scenery and showed to equal advantage in choice of subject, plan of attack and clarity of exposition. In his latest monograph[1], which includes forty-six illustrations, mostly air-photographs, he dealt with a problematical erosion form represented by tens of thousands of parallel, oval, marshy hollows pitting the coastal plain of America. The area affected measures some 25,000 square miles, and ranges through South Carolina into neighbouring States. Here marshes of any shape are commonly called 'bays', perhaps, it has been suggested, because bay trees flourish in them. This local practice accounts for the title selected by Johnson for his book, "The Origin of the Carolina Bays". Johnson alternatively speaks of the oval hollows as craters. They are shallow basins, measuring anything from a few hundred feet up to four miles in length, and averaging about 50 ft. in depth, when allowance is made for partial infilling with peaty silt. Usually they are more or less completely encompassed with white sandy rims.

The parallel oval hollows are patchily distributed over a terraced plain which, eighty miles inland, rises to a maximum elevation of 300 ft. above sea-level. According to C. W. Cooke's account, the surface consists of a veneer of Pleistocene marine sands, sandy loams and clays, often less than 50 ft. thick. These rest unconformably upon various Tertiary and Upper Cretaceous formations, which effectively conceal a depressed floor of ancient crystallines. The oldest of the Cretaceous formations, the Tuscaloosa, is still in the condition of sand with interstratified clay. Along with several of the later formations, it carries abundant water, sometimes under artesian head. True artesian, overflowing wells are a commonplace throughout the region.

The peculiar oval form characteristic of so many of the Carolina hollows was first brought to the notice of scientific men in 1895 by L. C. Glenn. He regarded it as produced under coastal or sea-bottom conditions; but I think we must follow Johnson in attributing the ovals definitely to the post-emersion history of the plain. Glenn's descriptions attracted little attention until reinforced by aerial photographs, taken for forestry and other purposes. Then in 1933 came a dramatic paper by F. A. Melton and W. Schriever, claiming the oval hollows as scars of a prodigious shower of meteorites. The main basis of this hypothesis was the amazing tendency to parallelism exhibited by the ovals of any particular district.

Melton and Schriever's appeal to heaven met with a mixed reception. Cooke and Johnson were early opponents. In the volume under review, Johnson devotes four chapters to its criticism, from which I select a few points which seem to justify his unbelief: (1) the parallelism of the ovals is not regional, for near the border of North and South Carolina the general orientation is south-east, whereas near that of South Carolina and Georgia it is south-south-east—here in passing it may be remarked that in the former locality the ovals are mostly elliptical, and in the latter egg-shaped, with the small end pointing south-south-east; (2) if the hollows were meteorite scars, they would almost certainly have to be attributed to meteorite explosions; but an explosion is necessarily quasi-instantaneous and therefore has a strong tendency to give a circular, not an elongated crater; (3) anyhow, the rims consist of clean, washed sand, in contrast with the loamy sand of the plain upon which they rest—they cannot be interpreted as made of plain sand thrown out by explosion; (4) no fragments of meteorites have been found in much the greater part of the region—though we must remember that no fragments of the great Siberian meteorite have been recovered and also that iron is soluble; (5) magnetometer search for buried meteorites has given unpromising results.

Cooke and Johnson, in attacking the meteorite hypothesis, agreed that every oval hollow held a lake during some formative stage of its career, and that the associated sand rim is in a sense a beach coupled with dunes. The rims are conspicuous in air photographs, because they carry very little vegetation. On the other hand, they seldom rise more than 10 ft. above the plain, though occasionally spreading outwards for several hundred feet across it. They are not infrequently multiple. So far, I think that Cooke and Johnson are correct; but, when they go on to claim wind-operated water as a main shaping agent of the ovals, I think they are mistaken. At first both authors invoked a longitudinal wind to account for the elongation and parallelism of the ovals; but eventually they abandoned this particular conception. Here in outline are their subsequent strongly divergent views.

Cooke thinks that a steady wind blowing across any lake with yielding shores tends to set up a rotating current, and that this current would assume a circular path if only the earth were standing still. Under existing conditions of earth rotation, he claims that the current tends to become elliptical with its major axis directed north-west in the northern hemisphere. He further considers that the ideal resultant ellipse would have an axial ratio equal to the sine of the latitude; and he quotes a number of Carolina ovals conforming with this quantitative plan. I confess that after reading what Johnson has to say on this subject, and Cooke's own recent reply[2], I think the latter's argument is faulty.

Johnson devoted the last seven chapters of his book to what he called his "hypothesis of complex origin". In it, wind-driven currents and waves are given much less importance than in his previous hypothesis. In fact he was prepared to hand over the making of the hollows, their elongation, parallelism and the rough shaping of their oval form to springs controlled by underground conditions. The only essential service he asked of the wind was to smoothe the shores of the ovals by removing headlands and, embanking bays, with concurrent development of sandy rims. Even so, I think it possible to demonstrate that he trusted too much to the wind and too little to the springs.

I think that Johnson paid too little attention to the phenomena of intersecting ovals as illustrated, for example, in the figure here reproduced. Surely one is bound to ask how, on Johnson's hypothesis, was the wind persuaded to leave intact cuspate headlands at the points of intersection of two contiguous ovals; and how was it educated to connect such headlands with a bar of drifted sand, which, continuing faithfully the curvature of the shore of one oval, utterly

disregarded the contour of the other. Clearly the formation of oval basin and oval rim was an operation one and indivisible. The rim sand can be called a beach if so desired, but it was thrown out, not drifted along. In this important matter, Melton and Schriever seem to me to have come nearer the truth than Johnson. I do not mean to say that the phenomena of intersecting ovals rehabilitate the meteorite hypothesis, but I do think that they entail a more violent use of Johnson's springs than their author thought necessary or at all desirable.

Before leaving the subject of wind, I may say that Johnson has convinced me that wind has often co-operated in important matters of detail. I refer especially to a frequent slight exaggeration of the curvature of the ovals on their eastern sides and a corresponding marked accentuation of rim development in the same direction. It looks to me as if, when the hollows were formed by spring action, a westerly wind was usually blowing.

INDEX MOSAIC OF AERIAL PHOTOGRAPHS COVERING PART OF BLADEN CO., NORTH CAROLINA. NOTE ELLIPTICAL FORM AND SOUTH-EAST TREND OF THE DARK MARSHES KNOWN AS 'BAYS'. NORTH IS AT TOP. THE LARGE 'BAY' SOUTH-EAST OF CENTRE IS THREE MILES IN LENGTH. FROM FIG. 29 OF "THE ORIGIN OF THE CAROLINA BAYS".

Let us now turn to consider Johnson's spring hypothesis. One of his main ideas is the eruption of an artesian spring through impermeable cover. This would result underground in a water-rise, the inverse of a waterfall; and Johnson thought that a water-rise must have a strong tendency to migrate up-dip through backward erosion of the impermeable obstacle that it has breached. Accordingly, he held that artesian springs at the surface in any particular locality will migrate parallel with one another in a direction contrary to that of the dip of the underground strata. Continuing, he pointed out that a stationary spring may be expected to develop a circular pool, if it emerges through a superficial deposit of loamy sand, because of removal of continually agitated material, in solution if soluble, or in suspension if of a clayey nature. Such a process would leave a residue of quartzose sand to be eventually collected together to form a rim—here it may be noticed that the rim sand outside any Carolina hollow is always of much less volume than the hollow itself. Johnson also considered that a circular pool thus formed would expand considerably through slumping of the loamy sand forming its banks. Finally, returning to his hypothetical migrating springs, he argued that at the surface they would act in all particulars like stationary springs, except that they would give elliptical instead of circular pools.

I consider that we must modify Johnson's spring hypothesis in certain particulars before we can adopt it. There are two main reasons: (1) it is extremely doubtful whether artesian springs show any marked tendency to migrate up-dip; (2) Johnson derives his oval hollows through intersection of successive circular hollows. Let us examine this last point. We have seen that intersection of oval hollows is characterized by cuspate headlands often connected by a well-developed rim. Intersection of circular hollows should be similarly advertised if it had really taken place.

Personally I accept Johnson's conception of spring action with linear application determined by some structure in an impermeable layer through which the water has risen; but I think that appearances prove that the spring of our hypothesis made a simultaneous attack all along the line, instead of starting at one end and gradually migrating to the other. This clearly indicates guidance by joints in the impermeable layer rather than by dip. Dip can, however, probably be retained as a factor of local importance. In some districts, as already stated, the ovals are egg-shaped. This would be expected if the top of the impermeable, jointed layer has a fairly pronounced dip in the direction of an opened joint that gave passage to rising water. It is clear that the water, issuing nearer the surface at one end of the joint than

at the other, would produce an asymmetrical result. I imagine the pool would narrow in the direction of dip.

It will be noticed that I have proposed a drastic reduction in Johnson's time-table. This involves a greatly increased call upon water supply, measured in gallons per hour. A little further thought shows, however, that the supply was maintained only for a very short period. The water which made a hollow with rim complete cannot have continued to flow on anything like the same scale after it had done this work. Otherwise it would have cut an escape channel of dimensions comparable with those of the spring pool. Many of the depressions do have escape channels, but these are on a scale commensurate with that of certain artesian springs which are occasionally to be identified in the marshy bottoms.

The sudden cessation of the springs of our modified hypothesis removes them at once from the artesian category. Such transient springs must depend on load pressure for their activation. When an earthquake shakes an alluvial district it generally leads to discharge of sand and water from numberless craterlets. I imagine the cause must be a repacking of wet sand into patches, some of compacted sand comparatively waterless, others of loose sand lubricated with water and incapable of sustaining load pressure unless furnished with outside support. As a result, almost immediately after an earthquake has occurred in a suitable locality, sandy water spurts up a few feet into the air from craterlets and fissures, and soon ceases to flow, seldom persisting for more than a few hours. I am inclined to think that some such subterranean re-arrangement of sand and water was responsible for delivery of water at the surface during the formation of the Carolina hollows. It would account among other things for the frequency with which activity shifted from one site to another. An area of underground sand, once repacked with extrusion of water, would likely remain stable in later recurrences of stress.

There are striking resemblances connecting the Carolina region with familiar fields of earthquake hydro-eruption, such as those of the Mississippi (New Madrid), 1811–12, Assam, 1897, and Bihar-Nepal, 1934. There are equally striking contrasts. I hesitate to suggest that the Carolina hollows are earthquake craters, but I do hold that the idea is worth serious consideration. Among resemblances is the vast area over which sanding from numberless craterlets may occur after an earthquake. J. A. Dunn, J. B. Auden and A. M. N. Ghosh have found this effect scattered throughout 18,000 square miles in connexion with the Bihar-Nepal earthquake[3]. The differences concern in part the relatively small size of known earthquake craterlets. An elliptical blow-hole at Muzaffarpur, measuring 25 ft. by 10 ft., is quoted as a large example (*loc. cit.*, p. 35). The craterlets seem to make up in number for what they lack in measurement. "In places the surface was riddled with sand vents, sometimes so completely that small areas up to an acre or so in extent, might be compared with boiling porridge. . . . The universality of the sand in some places, and the closeness of the vents, suggest no great depth for its origin, since the greater the depth of the channels leading up to the vents the more localised and separated would they probably be" (*loc. cit.*, pp. 34, 36).

Perhaps a more serious difficulty presents itself in regard to regional, as opposed to local, parallelism. Earthquake craterlets are often strung along fissures (furnishing possible composite homologues with individual Carolina ovals), and earthquake fissures may themselves be opened up into craters. This introduces a pronounced element of local parallelism, for earthquake fissures tend to be parallel with their contemporaries and predecessors in any small district. Recurrence of parallel fissuring is well illustrated in Charles Lyell's account of how the inhabitants of the New Madrid area, which shook again and again during a period of several months in 1811–12, felled trees at right angles to the fissure direction to serve as bridge-refuges for use should later tremors give warning of approaching trouble. On the other hand, many earthquake fissures are orientated on a strictly local basis parallel to topographical features, whether negative as in the case of the banks of a river or pond, or positive as in the case of a road embankment or heavy building. In the Bihar-Nepal earthquake, fissures on flat country "rarely showed any constancy in direction; more generally they occurred as an irregular network" (*loc. cit.*, p. 32). M. L. Fuller, however, found matters otherwise in the New Madrid area[4]. He recognized, indeed, that many fissures had been controlled by topography, but added: "the second class, or the simple fissures of the sandblow areas seem to have a tendency toward a definite arrangement, along northeast-southwest lines (averaging N. 30° E.), although where the blows are scattered the arrangement is not always very apparent. The fissures of the sand sloughs are in general parallel to the depressions and are even more commonly aligned in northeast-southwest directions". One must remember also a suggestion made long ago, and never so far as I know refuted, that much of the parallel jointing of rocks in general is an earthquake phenomenon. It is to be hoped that the next great ejective earthquake will be followed by a careful air survey.

[1] "The Origin of the Carolina Bays." By Prof. Douglas Johnson. (Columbia Geomorphic Studies, No. 4.) Pp. xii+342. (New York: Columbia University Press; London: Oxford University Press, 1942.) 30*s*. net.

[2] Cooke, C. W., *J. Geol.*, **51**, 419 (1943).

[3] Dunn, J. A., Auden, J. B., and Ghosh, A. M. N., *Mem. Geol. Surv. India*, 33 (1939).

[4] Fuller, M. L., *Bull. U.S. Geol. Surv.*, No. 494, 49 (1912).

# PAVLOV'S WORK ON HIGHER NERVOUS ACTIVITY AND ITS DEVELOPMENT IN THE U.S.S.R.

By FREDA M. THOMAS
London School of Medicine for Women

NEWS has recently been received from the U.S.S.R. of the work of Prof. Maria Petrova, who has been awarded the Order of the Red Banner of Labour by the Soviet Government for her work on problems connected with higher nervous activity*. Since she joined Pavlov's laboratory at the Institute of Experimental Medicine in Leningrad in 1910, she has carried out countless experiments in this field and even refused to interrupt her experiments during the recent siege. Prof. Petrova is typical of the majority of Pavlov's pupils, who, after his death in 1936 at the age of eighty-six, determined to carry on his work, and in the words of Prof. Frolov "to occupy

* All the recent information in this article has been obtained from cables sent by the Academy of Sciences of the U.S.S.R. For the use of this material I am greatly indebted to Sir John Russell, of the Anglo-Soviet Scientific Collaboration Committee of the British Council, and the Ministry of Information.

themselves with organizing new experiments so that by their collective labour the breach in their ranks might be made good"[1].

Before proceeding to the subject-matter of the cables concerning Prof. Petrova's work, it would seem fitting to give some account of the magnificent work of her master, Pavlov, the fundamental value of which, as was pointed out in one of his obituary notices[2], is shown by the fact that so much of it is now regarded as common knowledge.

Pavlov graduated from the Military Medical Academy in St. Petersburg in 1879 and worked as assistant to Tsion, the discoverer of the depressor nerve, until in 1884 he went to Leipzig to work under Ludwig, from whom he probably acquired some of his precision in observation. He then worked under Heidenhain at Breslau, absorbing some of his enthusiasm for science, and developed the technique of permanent fistulæ and isolation of parts of the gastro-intestinal tract. He returned to St. Petersburg in 1886 and was soon put in charge of Botkin's experimental laboratory, where he showed his talent for the organization of research. In 1890 he was made professor of pharmacology in the Military Medical Academy and five years later succeeded to the chair in physiology.

Throughout his work, Pavlov took pains to have conditions as normal as possible: for example, when working on the circulation, he endeavoured to accustom the dog to the insertion of a cannula, and in the construction of the 'Pavlov pouch', part of the stomach was isolated with negligible interference with the nerve supply. He emphasized the importance of surgery in experimental research, and of having healthy, well-cared-for animals, which he treated as human patients with regard to anæsthesia, asepsis, narcosis and care after operation. It was probably as a result of his work that scepticism arose as to the applicability to medical practice of results obtained from narcotized or decapitated animals. In 1891 he organized the surgical department of the physiology laboratory in the new Institute of Experimental Medicine, the first of its kind in the world, founded and financed by the Prince of Oldenburg, and it was here that he carried out most of his work on digestion, for which he received the Nobel Prize for Physiology and Medicine for 1904[3]. As Anrep pointed out in an obituary notice[4], most of the facts relating to digestion as it is now known either had their origin, or were established, in Pavlov's laboratory.

By 1906, Pavlov had transferred his investigations to the brain, but he used similar methods, still striving towards normality, carefully isolating his variables and keeping all other conditions constant. He focused his attention on the correlation between external phenomena and the reactions of the organism as a whole, and he followed the lead of Claude Bernard in regarding the animal body as an unstable system which constantly maintains its equilibrium with its environment; and for the maintenance of this equilibrium he was struck by the importance of conditioned reflexes.

As a result of his investigations into the so-called psychic flow of some of the digestive juices, Pavlov had become convinced of the futility of subjective methods of inquiry; he objected to psychologists applying their own experiences to the brain of the dog and asked: "to understand these phenomena, are we obliged to enter into the inner state of the animal, to fancy his feelings and wishes as based on our own?" His sham feeding experiments had shown that simultaneous excitation of organs of sight, hearing, taste or smell influenced the activity of gastric glands, and thus the idea of a complex subjective sensation was transformed into what he described as "a concrete factor of the physiological laboratory".

By gradually establishing conditioned reflexes through the simultaneous application of an 'essential' and an 'unessential' stimulus, Pavlov was able to substitute a more nearly normal animal for the study of behaviour than could be obtained by acute experiments involving artificial stimulation of different parts of the brain; and in Pavlov's life-time their study had made many important contributions to an understanding of the nature of sleep, neuroses and temperament.

The response selected for study was the secretion of saliva in dogs of which the salivary duct had been brought to the exterior of the cheek so that the quantity of saliva secreted in a given time could be measured. Pavlov pointed out that this choice, although originally accidental, satisfied the fundamental demand in scientific investigation for beginning with the simplest case; it also had the advantage of being easier to assess and less likely to cause complications than a motor response. The 'essential' stimulus was the giving of food, but the reflex could be conditioned to an infinite variety of stimuli such as the ticking of a metronome, the flashing of an electric lamp, the appearance of certain figures with varying intensities of illumination, a trumpet or telephone, rhythmic contact of blunt or sharp instruments with the skin, or warming and cooling particular parts of it. By these means, therefore, it was possible to learn much about sense organs and powers of discrimination, such as limits of audibility, distinction between metronome speeds, musical intervals and combinations of musical sounds, as well as much about the general and localized functions of the cortex.

Pavlov showed that association was a simple analysis followed by synthesis, then generalization, and finally analogy; since a dog could not only differentiate an interval in one part of the musical scale but also would respond to all such intervals in other parts of the scale. The fact that conditioned reflexes were lost if the cortex was removed confirmed earlier findings by Goltz that decorticated dogs showed no initiative, would only eat if food was placed in their mouths, and generally lacked the power to adapt themselves to changes in their environment. Pavlov and his workers increased the knowledge of the map of the cortex by establishing certain conditioned reflexes and finding whether or not they persisted after removal of different parts of the cortex, although it was shown that in time compensation occurred and some parts of the cortex could replace others.

Pavlov paid great attention to the welfare of his experimental animals, and minimized all experimental errors by mechanical appliances and by isolating his animals so that even the observer and operator were in an adjoining room. He was at one time in charge of three laboratories and sometimes had more than sixty people each working on a different problem, but he himself remembered the details of every investigation. His recognition of the value of the division of labour led to the organization of research teams, of which there are now so many in the U.S.S.R., the United States and Great Britain.

Pavlov's new laboratory at the Institute of Experimental Medicine in Leningrad was built with

funds from the Ledenzov Society for the Advancement of Experimental Sciences and their Application.

At Koltushy, now Pavlovo, a village twenty miles north of Leningrad, the Soviet Government built for Pavlov an establishment which combined laboratories with a rest-home for scientific workers. The buildings bore the inscription: "Experimental Genetics of the Higher Nervous Activity" and on the tower was Pavlov's watchword: "Observation and again Observation". Each animal had a separate dwelling-place and there was a hospital, exercising hall and maternity centre for the bitches. His two chimpanzees, Rafael and Rose, presented by Prof. Voronov, also had their own buildings.

Early in his study of conditioned reflexes, Pavlov showed that stimulation of the cortex produced excitation. This first spread over a large area and was described as irradiation, and would be followed by concentration, which would be accompanied by inhibition such as occurs where antagonizing muscles are concerned. He was engaged on this work when Maria Petrova, who had just graduated from the newly opened Women's Medical Institute in St. Petersburg, joined his laboratory in 1910. Her thesis for a doctor's degree in 1912 was entitled "Processes of Irradiation and Excitation in the Cortex of the Brain", and together with Krasnogorsky she performed many experiments on excitation and inhibition. She also studied sleep, which, as the result of their experiments, Pavlov was led to regard as generalized inhibition extending to some sub-cortical areas, just as he regarded hypnosis as localized or partial inhibition. She later participated in the work on experimental neuroses which were produced by causing interference between the two opposing processes, excitation and inhibition, leading to rupture or breakdown of the cortical mechanism. They studied animals with different types of nervous systems; and by producing experimental neuroses in dogs, in some of which inhibition predominated, whereas in others excitation was most pronounced, obtained conditions resembling easily recognizable psychical disorders in man. They made extensive use of caffein and bromides in carefully graded doses in the investigation and subsequent cure of these conditions[5,6], and Prof. Petrova recently received the Pavlov prize for her book on this subject. During the last years of Pavlov's life, he became increasingly interested in the applications of his work to psychiatry, and both Krasnogorsky and Petrova devoted much time to these problems. Although Pavlov stressed the importance of the objective approach to psychology, he pointed out the help which physiology might derive from the study of clinical cases. He therefore made use of psychiatric data and visited clinics and talked to the patients. He maintained a lively interest in therapeutic measures, and in his last year initiated the treatment of schizophrenia by prolonged sleep.

Petrova has also continued the work which Pavlov began on the relation between the endocrine organs and higher nervous activity. For example, they found it difficult to establish conditioned reflexes in thyroidectomized or senile dogs, and relatively easy to produce experimental neuroses in castrated dogs. Pavlov also showed the influence of the cortex on some endocrine activity; for example, a conditioned reflex was repeatedly reinforced by administration of thyroid extract; then, when the extract was no longer given, an increase in metabolic rate was obtained in response to the secondary stimulus.

In a cable from Moscow, Prof. Krikor Kekcheyov records that after Pavlov's death in 1936, Petrova joined Pavlov's oldest colleague and successor, Leon Orbeli, at the Institute of Physiology of the Academy of Sciences of the U.S.S.R. Her work there has included a study of the part played by the nervous system in the origin of malignant tumours, the production of experimental neuroses by the use of strong irritants of the nervous system, and in 1943 she established the connexion between the severity of disorders of higher nervous activity and the development of eczema and various tumours.

A cable from Petrova herself says that she has never left Leningrad for an hour since the War began as she knew that her great master Pavlov would not have done so. She gives a vivid description of conditions in that city and makes many bitter comments on the tyranny of the German invaders. During the siege, which lasted nine hundred days, she refused to leave the city in spite of being repeatedly urged to do so, and she says she found satisfaction in working sixteen hours a day and wrote twelve scientific papers, of which she mentions the following: "Conditioned Reflexes as a Method of Throwing Light on Mental Traumata and the Origin of Various New Processes, in particular Cancer", "Influence of Fear-inducing Factors of Military Operations on Higher Nervous Activity in Dogs with Differing Types of Nervous System", "Causes of Old Age and Prophylactic Measures against Premature Old Age". As a specialist in higher nervous activity, she was able to observe the psychology of her fellow citizens and records with pride that the harder life became in the besieged city, and the more savage grew the German persecution in the form of hunger and bombardment, the more clearly did she perceive the people's firmness, unbending will, 'comradeliness' and habit of mutual assistance. The Pavlov Institute of Physiology was among the many important buildings damaged by bombs and shells, but in spite of these attacks, research was not interrupted, and scientific workers in Leningrad also spared no effort to defend their city. For months the daily ration of the people was 125 gm. of bread containing only 50 per cent flour.

Pavlov considered that a certain degree of discomfort is good for a fertile mind, and that a shortage in apparatus and material trains resourcefulness. It is interesting to compare Prof. Petrova's description of work under the conditions of this War with an account of one of Pavlov's assistants of their work during the War of 1914 and the Revolution. "It was often very difficult to get to the laboratory at all, because, besides other things, there was often shooting and fighting in the streets"; but Pavlov was generally present even if he was the only one, and he severely criticized any late-comer if there was an experiment to be done. He continued his work in the laboratory on short winter days by the light of wood torches and used a kerosene lamp for lectures, in which there was no break either at the Military Medical Academy or the Institute of Physiology.

Pavlov was convinced that only science could lead the human race to a bright future free from war, revolution and catastrophe, and at the opening of the fifteenth Physiological Conference in Leningrad in 1935 he said, "War is by its nature a bestial method for solving the difficulties of life, a method unworthy of the human mind with its immeasurable resources", and he placed great faith in the efforts of the Soviet Government with Stalin at its head in its struggle

for world peace. In that year Cannon remarked that the outcome of the efforts, which were being encouraged by the Soviet Government, to use Pavlov's methods to condition the cortex in new ways and thereby to bring about a reformation of conduct would be watched with supreme interest[7]. Pavlov himself, in a letter to young scientific workers shortly before his death, said: "It is a matter of honour for the youth, as well as for all of us, to justify those great hopes which our fatherland places in science".

Pavlov has been accused of over-simplifying a remarkably complex subject, but his theories have provided useful working hypotheses and they have stimulated effort and increased the extent of careful experiments by those who agreed as well as those who disagreed with his views. He himself considered theories as worth while only for finding new lines of attack and accumulating facts. He stressed the importance of repeated tests to establish the reproducibility of results, and he shrank from making general conclusions. His work affords a striking example of true scientific method, and it is satisfactory to learn that his colleagues in the U.S.S.R. have been able to develop it still further in spite of the difficulties of war conditions.


[1] Frolov, "Pavlov and His School" (London: Kegan Paul, Trench, Trubner and Co., Ltd., 1937).

[2] *Proc. Roy. Soc. Edin.*, **56**, 264 (1935–36).

[3] Pavlov, "The Work of the Digestive Glands", translated by W. H. Thompson (London: Charles Griffin and Co., 1902).

[4] Anrep, Royal Society Obituary Notices, 2 (1936).

[5] Pavlov, "Conditioned Reflexes" (Oxford: Univ. Press, 1927).

[6] "Lectures on Conditioned Reflexes", Pavlov. Vol. 2, translated and edited by W. Horsley Gantt (International Publishers, 1941). See also Vol. 1.

[7] Cannon, W. B., "Ivan P. Pavlov", *Res. Bull. Sov. Union* (1935).


# THE ROYAL NAVAL SCIENTIFIC SERVICE

DURING the War of 1914–18 technical progress went ahead, as has again happened in this War, at a vastly increased rate in all the Services. In order to compete with the demands for new weapons and counter-measures, the help of numbers of men of science from the universities and technical men from private firms was enlisted, and these men were employed in naval establishments all over Great Britain. They were employed very largely on new methods for detecting and destroying enemy submarines and on developments in radio, new types of mines, methods of mine-sweeping, work on underwater explosions, torpedoes and navigational devices and the like. The work of these men was of immeasurable value to the Navy, and directly after the War the Admiralty decided, as a result of its experiences during the War, to set up a civilian scientific research department under a civilian Director of Scientific Research. The first Director of Scientific Research in the Admiralty was appointed at the beginning of 1919. He was Sir Frank Smith, who had himself during the War been largely concerned with the development of a type of magnetic mine which can be regarded as a forerunner of the German magnetic mine, which was used against Britain during this War. The Admiralty also set up its own research laboratory under the Director of Scientific Research for the conduct of the more fundamental types of scientific investigation.

Gradually during the years of peace the civilian scientific and technical staffs employed in the Naval Establishments were put under the general administrative control of the Director of Scientific Research, instead of being separately administered as they had been during the War. These staffs were embodied in the Admiralty Scientific, Technical and Chemical Pools, and this arrangement ensured a greater measure of uniformity in the conditions of service in the different establishments, and among people engaged on different types of research and development work, and it also ensured common methods of selection and entry into the scientific, technical and chemical services of the Admiralty. During the years of peace also, the Air Ministry and War Office set up civilian scientific research departments, which were modelled very largely on the Admiralty organization.

The steps outlined above were steps in the right direction, but there is no doubt that the Navy, and indeed the other Services, suffered a good deal because the conditions of service of the civilian technical staffs were not such as could attract the best types of men from the universities and other sources upon which the Admiralty depended. Apart from pay and promotion prospects, the lack of opportunity for publication and loss of outside recognition, as well as rather rigid research programmes, were against the Services in their need for first-rate men.

Some of the men of science and engineers who entered the Admiralty Service in the War of 1914–18 are still there, and it is to the work of these men and to those who entered the Service during the years of peace that we owe our state of preparedness, such as it was, to meet the onslaught of Germany. During the present War, the permanent Admiralty staffs have again been greatly strengthened in numbers and in quality by men of science and engineers drawn again from the universities, research institutions, private firms and other sources. The great advances which have been made in almost every form of technical weapon and in counter-measures are largely due to this body of people, working in the closest daily association with industry and outside men of science and engineers, including those of the United States and the Dominions, with the naval technical departments, and with the divisions of the naval staff, who decide in broad outline what are the Service needs.

The announcement of the formation of the Royal Naval Scientific Service is an indication that the Admiralty, having been the first Service department to take the then epoch-making step of setting up a civilian research department within its organization, still recognizes the vital importance of taking yet further steps to ensure that scientific research and technical development for the Navy shall not lag behind during the future years of peace.

The Admiralty desires to see the closest co-operation between the men of science and the uniformed officers of the Service, and it proposes giving fuller opportunities than have hitherto been regularly possible for civilians to become thoroughly versed in the ways and the needs of the Service. Further, the civilians will, by virtue of the arrangements which will be made for obtaining sea training and experience, come to feel that they are more than ever before an integral part of the Navy. The Fleet Order shows also that the Director of Scientific Research, as head of the Royal Naval Scientific Service, will have greater freedom than hitherto in arranging for transfers of staff between establishments, so that the outlook of the technical men will become broader and more enlightened than it is apt to be if men of science and engineers specialize too long or too early in

particular aspects of Naval warfare. The reference to conditions of service including pay and prospects of promotion is vague, but it must be accepted at present as an earnest of the good intentions of the Admiralty.

The Admiralty and Government policy towards research in post-war years aims at giving research and research workers—in the broadest sense—recognition and status which they have hitherto lacked in Great Britain. It is also hoped that the R.N.S.S. will be accounted an honourable career for men whose leanings are towards science and the sea; that prospects offered by the R.N.S.S. will attract men of the highest calibre to devote their minds and their lives to solving the great problems which lie ahead of the Navy; that, though the Government service cannot generally offer monetary rewards comparable with those of the highest walks of industry, yet the other advantages of a Naval technical career will offset the possible financial disadvantage; that the Admiralty will be enabled to keep after the War some of the brilliant men who are serving it temporarily now; that there will be greater freedom for individual research workers to follow up lines of investigation for which they are personally fitted, and that the Government will not be so much inclined to look for quick returns.

# OBITUARIES

## Sir Arthur Smith Woodward, F.R.S.

SIR ARTHUR SMITH WOODWARD, lately keeper of the Department of Geology, British Museum (Natural History), died on September 2 at the age of eighty.

Sir Arthur was a great student of vertebrate palæontology, the widest in his work and knowledge of his time. When he left Owens College, Manchester, as a very young man to take a post in the Museum, he recognized that the work of R. H. Traquair on palæozoic fish had introduced a new standard of investigation and a new outlook, and immediately applied them to the study of later fishes. He travelled extensively so that he saw nearly all the original materials in the world, and his extraordinary memory enabled him to recall immediately anything which could throw light on the fossils on which he was actually working. Thus his catalogue of the fossil fishes in the British Museum marks an epoch in the study of such things. It was the first completely general detailed work since Agassiz's "Poissons Fossiles" and it has had no successor, so that it remains the point of departure from which all subsequent work has proceeded. To him came collections of fossil fish from every part of the world, to be in turn described, placed in their position in the classification, and their geological horizon determined. Thus he became known to palæontologists everywhere, and was ultimately a foreign member of some twenty scientific societies.

But Sir Arthur's interests extended far beyond fish. He wrote on fossil Amphibia, reptiles, birds and mammals, doing something of interest in each of those groups, and finally he described the Piltdown man, actually himself finding part of the material at Piltdown.

His quality was well illustrated by the text-book of vertebrate palæontology which he published in 1900. This differed in every way from those which then existed; it was accurate, it dealt only with forms which were important morphologically, it was based entirely on materials which the author had seen, and it was readable.

When Sir Arthur entered the Museum the collections of fossil vertebrates, though large, had not been brought together on any considered plan. Under his influence and guidance they were expanded so that every important fauna in the world was represented, often by most admirable materials. But all were bought, sometimes after they had been sought for many years. Although Smith Woodward himself made a collection of fossil mammals at Pikermi, and Andrews explored the Fayum, no expedition was ever sent out at Museum expense; in consequence, during the past thirty years many foreign museums have exploited fossil faunas which are now inadequately or not at all represented in London.

But Smith Woodward always felt that he was a public servant. Everyone, British or foreign, had access to all the fossils in his charge, and was allowed to describe anything he wished. Thus the Museum gained because its collections were worked over by men from many countries, and palæontology gained because specialists could use its materials, as if they belonged to their own institutions.

So Smith Woodward became known and admired by the whole body of palæontologists, occupying a place no one can now fill, and leaving behind a great mass of admirable work, part of the foundation of modern palæontology. D. M. S. WATSON.

## Prof. S. P. Mercer, O.B.E.

THROUGH the death of Prof. Stephen Pascal Mercer which occurred on August 18 at the comparatively early age of fifty-three, Northern Ireland has lost an outstanding figure in the field of agricultural education and one who played a prominent part in laying a sound foundation for the Faculty of Agriculture of Queen's University, Belfast.

S. P. Mercer (S.P.M., as he was known to so many of us) was a Staffordshire man—the son of Mr. Fred Mercer, the landscape painter—and was born at Abbots Bromley in 1891. His leaning towards the study of agricultural science became apparent at an early age and is confirmed by his career as a student at Harper Adams, the Botanisches Staatsinstitut, Hamburg, and the South-Eastern Agricultural College. He was a graduate in agriculture of the University of London, and held the National Diploma in Agriculture. Before coming to Northern Ireland, Prof. Mercer held appointments as lecturer in charge of the Department of Agricultural Botany at Armstrong College, adviser in agricultural botany for the northern counties of England, and divisional organizer for the Northern Province under the Food Production Department of the Ministry of Agriculture and Fisheries. During 1919–22 he was assistant director and chief research officer in the Seed Testing Station for England and Wales. It was while holding this appointment that he made his survey of seed growing in Great Britain, which is the best known of his earlier work.

On his appointment, in 1922, as head of the Seed Testing and Plant Disease Division of the Ministry of Agriculture for Northern Ireland, he threw himself energetically into the organization of the Northern Ireland Seed Testing Station, where his long experience

and intensive knowledge of seeds and seed testing allowed him to build effectively and have left their mark on this Station as it exists to-day. The study of seeds and allied problems provided his main interest on the research side, and his book, "Farm and Garden Seeds", which is remarkable for the accuracy and beauty of its hundreds of illustrations of seeds drawn in black and white and for the attractive style of its writing, portrays him at his best. His appointment as chairman of the Research Committee of the International Seed Testing Association established his claim to international reputation. His ability was soon recognized by the rye-grass seed-growing industry in Northern Ireland, and his loss will be keenly felt by all those engaged in seed production, who looked to him continually for good advice and wise counsel.

As professor of agricultural botany (1924), dean of the Faculty of Agriculture (1928) and senior technical research officer of the Ministry (1928)—which posts he occupied at the time of his death—S. P. Mercer will be remembered by colleagues and students alike for his width of vision as a teacher, for the conscientiousness of his effort to give sound advice and for his unfailing courtesy. He became dean of the Faculty within a few years of its formation, and during his tenure of this office he succeeded in establishing it on sound lines, and gained and retained the respect of all in so doing. His conspicuous services to agricultural education and research in Northern Ireland were marked by the award of the O.B.E. in 1943.

At the outbreak of war he undertook additional duties in connexion with the control of seed production and distribution in Northern Ireland, and here he was able to bring his knowledge and experience to bear in assuming his not inconsiderable share of "the war effort".

Mercer did not enjoy robust health; he worked under a handicap which few of us are asked to bear, and knowledge of this only serves to emphasize the greatness of his achievements. A lover of peace, prevented by indifferent health from fighting to secure that peace, artist and idealist as well as man of science, gentle and retiring of nature, blessed with constancy of affection, he would have achieved much more had the strength been his and had his span of life been longer. We, his colleagues, mourn the loss of a fine and ardent spirit, an upright and just man rightly disturbed on occasion by the blatant and consistent imperfections existing in our race and grieved at his powerlessness to do more to put wrongs right. A. E. MUSKETT.

## Prof. Leo F. Goodwin

WE record with regret the death of Lieut.-Colonel Leo Frank Goodwin, professor of chemical engineering at Queen's University, Kingston, Canada, on August 15, at the age of sixty-six. He was the elder son of the late Oscar Guttmann, author of "The Manufacture of Explosives" and of "Monumenta Pulveris Pyrii". Prof. Goodwin received his engineering training at the City Guilds Central Technical College and then took his Ph.D. in chemistry at the University of Heidelberg. He was a member of the Institution of Chemical Engineers and of the Engineering Institute of Canada and a fellow of the Institute of Chemistry. He became assistant to Sir William Ramsay at University College and held an assistant professorship for some years at the City College, New York, before taking up his chair at Queen's University. There he inaugurated the first comprehensive course in chemical engineering in the British Empire. An enthusiastic advocate of an undergraduate curriculum for chemical engineers, he probably turned out during the last thirty-five years a larger number of fully qualified and successful chemical engineers than the rest of the British Empire, exclusive of Canada.

His published work dealt mainly with large-scale chemical processes such as the manufacture of pulp for paper, acetone, causticizing and cement colouring, and he was employed as consultant to some of these industries.

Prof. Goodwin also had a distinguished military career, first in the squadron of the Inns of Court Rifles and then in the Princess of Wales Own Rifles, Canada, which he commanded for some years. In September 1914 he came to England with the 1st Canadian Division and served with them in France and Flanders during the critical 1915 campaign. After the battle of Givenchy he was seconded for service with the Canadian Munitions Board and rendered valuable technical service to the British and Allied Governments.

During the present War, Prof. Goodwin again served the Canadian Government in a military and technical capacity, and latterly supervised a number of selected research students engaged on Government sponsored research work. There is little doubt that his early demise was hastened by a long period of overwork.

Prof. Goodwin leaves a widow well known as an artist under the name of Helen Sinclair and a daughter now in the Canadian W.A.A.F. He will be greatly missed by a wide circle of friends here and in America.

R. ROBERTSON.

## Dr. M. C. Mott-Smith

DR. MORTON C. MOTT-SMITH, writer in physics for Science Service, Washington, died on June 9. He was sixty-six years old. Although he joined the staff of Science Service less than three years ago, he had completed since then two important fundamental texts in physics for use in high schools and by soldiers and adult civilians. Of one of these—"Fundamentals of Electricity"—more than 650,000 have been printed, including editions for the use of the American Army and a translation into Spanish.

Dr. Mott-Smith was born in Hawaii on November 26, 1877. He graduated from the Massachusetts Institute of Technology in electrical engineering and obtained his Ph.D. in physics, philosophy and mathematics at the University of Halle, Germany. He was formerly professor of physics at Colby College and George Washington University.

WE regret to announce the following deaths:

Prof. J. C. W. Frazer, research professor of chemistry in Johns Hopkins University, on July 28, aged sixty-eight.

Sir John Jarmay, K.B.E., a director of Brunner, Mond and Co., Ltd., and of other chemical works, on August 22, aged eighty-seven.

Prof. D. E. Smith, emeritus professor of mathematics in Teachers College, Columbia University, on July 29, aged eighty-four.

Mr. H. F. Tomalin, formerly conservator of forests, Ceylon, on August 16, aged eighty-two.

# NEWS and VIEWS

## University of Bristol:

### Chair of Chemistry

It has been announced that Dr. Wilson Baker is to succeed Prof. E. L. Hirst as Alfred Capper Pass professor of chemistry in the University of Bristol. Dr. Baker studied in the University of Manchester and, after a period of service in France with the Friends' War Victims Relief Organisation, he obtained the degree of B.Sc. with first-class honours in chemistry in 1921. He then held successively the Mercer scholarship, the Baeyer fellowship and the Dalton scholarship for research in chemistry, and on taking the Ph.D. in 1924 he was appointed assistant lecturer in Manchester. In 1927 he joined the chemistry staff in the University of Oxford and has also held for some time the position of fellow and prælector in chemistry at the Queen's College. He received the degree of D.Sc. (Manchester) in 1933.

Dr. Baker is distinguished as an organic chemist whose work has developed markedly our knowledge of various groups of natural products. Special reference may be made to his contribution to the chemistry of flavones and *iso*-flavones and the polyhydroxybenzenes. In addition to work on natural products, Dr. Baker has made important contributions to the theory of chelated compounds of the aromatic series, and has given attention to the study of condensation products of phenols with ketones. Along with Mr. T. W. J. Taylor, he undertook a revision of Sidgwick's "Organic Chemistry of Nitrogen", the new edition of which was published in 1937. Dr. Baker hopes to commence his work in Bristol at the beginning of January 1945.

### Chair of Civil Engineering

The appointment of Dr. A. G. Pugsley to the chair of civil engineering at the University of Bristol has been announced. As an acknowledged authority on structures, he will be able to maintain a tradition established by his predecessors, J. F. Baker and A. J. Sutton Pippard. Dr. Pugsley was educated at Rutlish School, Merton, took his London degree in engineering at the Battersea Polytechnic, and followed this by an apprenticeship to civil engineering at the Royal Arsenal, Woolwich, under Colonel H. Mitchell. He then joined the staff of the Royal Airship Works, Cardington, and was engaged upon problems of structural design until the establishment was broken up by the Government's decision to discontinue airship development following the accidental loss of the *R*.101. He transferred to similar work on heavier-than-air craft at the Royal Aircraft Establishment, Farnborough, and later was appointed head of the Structural and Mechanical Engineering Department there. During part of this period he held the appointment, by arrangement with the Air Ministry, of part-time lecturer on aircraft structures in the post-graduate Aeronautics Department of the Imperial College of Science and Technology, South Kensington, London. He resigned this in 1941 owing to pressure of official duties at Farnborough.

Dr. Pugsley's researches have been mainly in the field of elasticity in aircraft structures, upon questions of interaction of aerodynamic loading with structural elasticities and inertias, and the development of airworthiness design regulations putting these into practice. He was awarded the D.Sc. by the University of London for this work. His activities at Farnborough included a notable expansion of the experimental work on structures, including investigation of structural accidents. He was awarded the O.B.E. early in the present year.

## Society for Visiting Scientists

The Society for Visiting Scientists was founded on the initiative of the British Council, and in consultation with the Royal Society, to provide a meeting place and information centre for men of science from overseas visiting Great Britain. The premises at 5 Old Burlington Street, W.1, consist of a lounge and meeting rooms, a bar, refectory, and some dormitory accommodation. These are at the disposal of members. The information centre is open to all visiting men of science, so anyone arriving in Britain can, if he wishes, proceed at once to the House and be given advice and details of how he can apply for membership. Under the present conditions it was decided to postpone the official opening for the time being; but the Society has been functioning unofficially for the last few months and has already been used by a number of British and foreign scientific workers, including members of the French Scientific Mission. It is hoped that an official opening will take place in the near future. In the meantime the Executive Committee has held an informal reception. On this occasion the president, Prof. F. G. Donnan, pointed out the importance of offering hospitality to young scientific workers, and deplored the lack of facilities for them in the past. He added, "I hope sincerely that this modest beginning will be but the nucleus of something much greater and more widely spread, something that in the happy days to come will contribute to the friendship, intercourse, and good fellowship of scientists throughout the world".

## Rehabilitation of Liberated Countries

The rapid advances of the Allies in both eastern and western Europe has brought into prominence the vitally important task of carrying relief to the suffering peoples and helping them to restart their agricultural and industrial activities. Several conferences have recently been held both in Great Britain and in North America dealing with the many important problems involved. The work falls into three stages. During the period of military operations it is in charge of the Civil Affairs Branch of the Army. Military necessities must obviously be of over-riding importance, and the closest liaison with the military authorities is essential. This organization will deal with the emergency period, but ceases to act when the military operations have ceased. At that stage a National Government will take charge, and it can look to the United Nations Relief and Rehabilitation Administration for advice and supplies for completing the relief measures and restarting the agricultural and industrial life of the country.

The work of U.N.R.R.A. falls into several sections: supplies of food, clothing, agricultural materials, machinery and spare parts for restarting damaged factories, especially those concerned with food; and with the returning of the scattered populations to their homes. Expert committees have collected data and worked out bases of allocations and priorities. The combined boards in Washington will furnish the most important supplies, and although reserves of food are not yet available owing to military demands

and those of the Civil Affairs Branch, U.N.R.R.A. has already received substantial allocations of other principal items including clothes, seeds and medical stores. In addition, U.N.R.R.A. has established a claim on crops still to be harvested, on clothes to be made, etc. The agricultural and industrial requirements are closely linked: if, for example, the flour mills could be started, it would be possible to send wheat into the countries assisted; and this would provide not only bread for the people but also milling offals that would produce milk and also animal manure to enrich the soil. Fishing also is to be restarted.

The third stage is reached when the agricultural and industrial life of the country is beginning to function normally; at that stage U.N.R.R.A. ceases to operate as its purposes do not include reconstruction. Organizations have been designed for dealing with the new problems that will arise. A permanent world food and agricultural organization is to be established, and a draft constitution has already been agreed. Its functions will include the collection, analysis and dissemination of information about nutrition, food and agriculture. It will promote and recommend national and international action on research and education in these subjects; also on the conservation of resources, improved methods of production, marketing and distribution, and the provision of adequate agricultural credit; it will also furnish technical assistance to Governments when required. No term is set to the operations of this body.

## A Medical Service in Ethiopia

AN opportunity for immediate medical service—and especially, it would seem, for service by trained nurses—is indicated by an article by Dr. Ruth Young, formerly principal of the Lady Hardinge Medical College for Women, New Delhi, on "Medicine and Nursing in Ethiopia" (*The Lancet*, 797; June 17, 1944). Although it is difficult to assess accurately the incidence of particular diseases in Ethiopia, because no vital statistics exist, Dr. Young has been able to gather valuable information about the physique, diet and general health of the people. The physique of the people living on the plateau is fairly good, and they are strong and hardy. The common diseases are typhus, relapsing fever, pneumonia, venereal diseases, dysenteries, trachoma and such parasitic diseases as scabies, tropical ulcer, infestations with intestinal worms and malaria. Leprosy is fairly widespread; but tuberculosis is apparently not so serious a problem as it is in other parts of Africa, nor do diseases due to deficiencies in diet seem to be common. From what Dr. Young says there would seem to be as much need of agricultural and veterinary assistance as of medical help. The cows are poor milkers and, although goats are numerous, they are kept chiefly for meat and skins and are not much milked. On the other hand, any increase in production of animal food products would, it seems, be largely neutralized by the numerous fasts imposed by the Coptic Church, which, apart from a longer Lent than ours and other fasts, forbids the use of foods of animal origin on two days of every week. Butter, milk and eggs are included in these forbidden foods.

Maternal mortality is apparently low, and complications at childbirth are not common. Dr. Young attributes this to the fact that most births are normal and to the very strong prejudice against any kind of interference at childbirth. There is no class of professional midwives similar to that which does "such untold damage in a country like India". Infant mortality is, on the other hand, probably very high. From questions addressed to women, Dr. Young learned that 176 out of 353 children born alive had died, and she concluded from the evidence available that something like 109 of these had died before the age of one year. There is also a high rate of sterility, probably due mainly to syphilis which, like gonorrhœa, is common. The chief needs at the moment are, Dr. Young thinks, intensive preventive work and the teaching of mothercraft and hygiene rather than the provision of hospital beds. There are at present no properly trained nurses. In an annotation on this interesting article, *The Lancet* (795; June 17, 1944) refers to the hospital to be built in Addis Ababa in memory of the late Princess Tsahai. Most of us will remember the tragic death of this young daughter of the Emperor at the age of twenty-two. In Great Britain, while she was in exile, she qualified as a State registered nurse after training at the Great Ormond Street Hospital for Sick Children, London, and later she took further training at Guy's Hospital. Returning home, she married the governor of a province in Ethiopia and began to organize the health service which she wished to see in her own country.

## Simple Teaching Apparatus in Physics

IN his presidential address given to the Essex Science Teachers' Association, Lord Rayleigh asks, and discusses, the question "Are Expensive Appliances Necessary?" In the physical laboratory a great deal can be learnt about Wheatstone's bridge by means of a wire stretched along a rough board, graduated with ink or pencil marks, with a piece of metal held in the hand to make contact with it at any point. From a purely teaching point of view this is as good, if not better than, a post-office box costing as many pounds as the other does pence. It is much less likely to muddle the beginner and will in all probability give him more insight into the physics of what he is doing. If the student has rigged it up for himself he will further get a sense of independence and achievement which he never gets by handling the elaborate constructions of the instrument maker. It is not uncommon to find people who regard an optical instrument not as an arrangement of reflecting and refracting surfaces, but as a construction of lacquered brass. The schoolboy first regards a telescope as a thing which 'pulls out'. All the essentials of the instrument can be better appreciated by sticking lenses with 'Plasticene' on a strip of wood. Helmholtz told Lord Rayleigh that as a boy he made his own telescope out of spectacle lenses and a cardboard tube. In instruments made by the instrument maker many essential parts are rightly hidden from view by protective devices, and the young student is deterred from meddling with them for fear of damaging valuable property.

## Simple Apparatus in Physics Research

IN the same address Lord Rayleigh claims that beginners in research also should be "graduates in the school of string and sealing wax". Faraday, and Maxwell in such constructions in the Cavendish Laboratory as his model of the thermodynamic surface, are each quoted as examples. Sir Charles Parsons, the greatest mechanical engineer of his generation, was able to deal with formidable problems

of large-scale construction, yet he found paper, sealing wax, wire and steel knitting needles very adequate materials for making a working model of his air turbine. When the late Lord Rayleigh had occasion to set up a pair of mirrors for Fresnel's interference experiment he mounted them in a few minutes on two lumps of soft wax. The amateur method is not only much cheaper but also often takes little more time than the dispatch of an order to the instrument maker. Progress, too, can be made while the mind is red-hot upon the project, before delay has cooled enthusiasm. Little sympathy is shown for the research worker who puts the responsibility for designing his apparatus upon a firm of instrument makers. Lord Rutherford is quoted as saying that, if necessary, he could carry out research at the North Pole. J. C. McConnel, who was compelled for health reasons to winter in Switzerland out of reach of laboratories or facilities of any kind, still made important observations on the crystallization of ice, noting in particular how large were the individual crystals and how they behaved under bending forces when single crystal rods were cut in various directions. Lord Rayleigh paid a tribute to the instrument making industry and its part in practical life and non-pioneering research.

## The New Carnegie Cyclotron

A NEW giant cyclotron has recently been put into operation at the Department of Terrestrial Magnetism of the Carnegie Institution of Washington. The new cyclotron, one of the two largest in operation in the world (the other being at Berkeley, California), generates particles of 15,000,000 electron volts energy, permitting the most precise measurements ever made of the forces released by atomic disintegration. The cyclotron itself weighs more than 225 tons, has an overall height of 12 ft.; it is 30 ft. long and 20 ft. wide. It took four years to build, at a total cost of 500,000 dollars for the cyclotron, its appurtenances, and the special three-story building housing the equipment and instrument shop. The magnet is made up of four iron castings, the largest weighing more than fifty tons. Surrounded by this heavy magnet is the accelerating chamber, about sixty inches in diameter, in which atomic particles are produced. The cyclotron is housed ten feet below ground.

## A New Type of Still

THE *Bulletin and Laboratory Notes* of September 1943, issued by Messrs. Baird and Tatlock, Ltd., Esher, Surrey, contains a description of an interesting copper and glass still for the preparation of distilled water in the laboratory. The water is boiled by an electric immersion heater in a tinned copper boiler, with a water-sealed lid of the same material. The lid carries a central metal tube over which is a glass hood communicating by a backward-sloping glass tube to the special water-cooled spiral glass condenser. A horizontal baffle inside the lid under the central steam outlet minimizes the passage of spray into the hood, which also serves as a trap. More than 90 per cent heating efficiency is claimed. The standard model has a 1·8 kW. motor and produces 2·7 lit. of distilled water per hour, with a total water consumption of 36 lit. The water, in a particular experiment, had a *p*H of 6·0–6·2, and conductivity 1·5–2·0 gemmohs, although these figures will vary with the quality of the tap water. Oil or gas heating may be used in emergency. The whole apparatus is conveniently mounted in one piece by suitable clamps and appears to be very robust, and an additional feature is that a supply of hot cooling water can be diverted to a tank near a sink and used for washing. Other interesting types of stills are also described in the *Bulletin*.

## Institute of Industrial Administration: Awards

THE Institute of Industrial Administration has awarded the Institute travelling scholarship to Mr. A. G. Irvine for his thesis on "The Purposes and Techniques of Market Research". This scholarship, of the value of £250, enables the holder to spend three months in the United States studying American practice in his particular field of management, assisted by the New York office of the donors of the scholarship, Messrs. Stevenson, Jordan and Harrison, Ltd. The Wilson Medal of the Institute has been awarded to Mr. A. W. Goldstaub, for his paper on "Internal Audit in Industry". The Junior Executive Prize of books to the value of £5 has been won by Dr. W. L. Kent, for his paper on "The Application of Science to Industry", and Mr. G. Kinnaird Evens, for his paper on "The Future of Psychology in Industry".

## "Books: The Warehouse of Knowledge"

WITH reference to the leading article "Books: the Warehouse of Knowledge", published in *Nature* of September 9, p. 319, Mr. Stanley Unwin writes: "If the established book publishers had as much as 5 per cent of 'the paper in the country available for printing' they would be in clover. The total of 420,000 which you give merely includes four categories of paper consumers and omits all others such as the printers. At the beginning of the War it was estimated that books called for about 1½ per cent of the total. It is unlikely even to-day that the figure exceeds 2 per cent." We regret our error in stated percentage of paper available, and since it was a considerable over-estimate, Mr. Unwin's correction adds still further point to our argument. It may be possible, however, that even Mr. Unwin's figures need correction, so far as books are concerned, for, as *The Bookseller* of September 14 points out: "These usages, however, do not consume all the paper available for printing. There is, in addition, an unknown but obviously considerable quantity of printing paper employed outside the above categories; for instance, the paper used in company reports, trade catalogues, and for a large variety of other commercial purposes".

## Announcements

THE title of reader in timber technology in the University of London has been conferred on Dr. F. Y. Henderson in respect of the post held by him at the Imperial College of Science and Technology.

MR. F. E. HUGHES (assistant conservator of forests, Gold Coast) has been appointed senior assistant conservator of forests, Gold Coast.

ACCORDING to the August issue of the *Anglo-Swedish Review*, the birth-rate figure in Sweden for the first quarter of 1944 of 33,261 was the highest recorded for this period since 1921; the figures for the corresponding period in 1943 and 1942 were 30,079 and 26,240 respectively. More children were born in the towns than in the country, the birth-rate figure for Stockholm being especially high.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Phytic Acid and Phytase in Cereals

The interesting letter of Dr. R. A. McCance and Miss E. M. Widdowson in *Nature* of May 27[1], in which they point out the relatively large quantity of phytase in wheat as compared with oats, gives me the opportunity of recording some further facts on this important practical issue which supplement those given in the letter. This is no mere academic question, but concerns what in the past certainly has been, and in my view possibly still is, the most prominent problem of malnutrition affecting people in Great Britain.

Cereals form such a large part of the national dietary, namely, about 50 per cent, that, if they have a nutritional defect, it is certain to be of great consequence to health and development. What we must aim at is to get all the advantages of these valuable foods and at the same time to eliminate or prevent any baneful action they may have. Now, cereals have such a defect in that they are not only poor in calcium content but also they can, under some conditions, interfere with the availability to the body of calcium of other foods[2]. This is of special importance to the child and adolescent, whose needs for calcium to incorporate in the growing bones, the developing teeth and other organs are great. In the adult animal also cereals can denude the bones of their calcium salts under some conditions. Contrary to all expectation, cereals such as oatmeal and maize, which contain most calcium, are just those which can interfere most with calcium deposition during growth.

In 1939 it was found that one substance in cereals which plays a large part in this harmful action is phytic acid[3]. Any form of treatment which reduces the phytic acid in cereals either by eliminating it or by hydrolysing it will reduce the rickets-producing or anticalcifying effect. It was found that malting of cereals, and, more especially, germination followed by autolysis of the crushed grain, reduce this action; and now McCance and Widdowson have emphasized the importance of the hydrolysis of phytic acid that accompanies the change from flour to bread as the result of the action of the abundant phytase in the flour. They point out that oats and oatmeal, on the other hand, contain but little phytase to break down the phytic acid. They suggest that the difference in phytase content of wheat and oats explains the results described many years ago of the smaller rachitogenic action of bread as compared with oatmeal[2].

That this explanation is true is undoubted, but it is only part of the truth. Oats and wheat are both rich in phytic acid. In my experience oats are the richer source, but the variation in different samples of both grains is large and for the purpose of the argument we will assume that the amount is the same in each cereal and of the order of 200 mgm. phytic acid phosphorus in 100 gm. of the grain. Now the husk which is removed in the preparation of the oatmeal forms about 30 per cent by weight of the grain, and since this husk contains no phytic acid (it does contain a little phytase) the percentage of phytic acid in the dehusked grain rises correspondingly, namely, up to 270 mgm. or more of phytic acid phosphorus per 100 gm. oatmeal. On the other hand, in processing wheat to flour, assuming that the wheat-meal flour is of 85 per cent extraction, the 15 per cent removed in the milling is largely made up of the coarser bran, which is very rich both in phytic acid and phytase. Thus 85 per cent extraction wheat-meal flour would contain about 120 mgm. or even less phytic acid phosphorus per 100 gm. flour. Starting, therefore, with oats and wheat grain both containing 200 mgm. phytic acid phosphorus per 100 gm. of grain, by the time each preparation reaches the cook, there is a great difference between their contents: 270–300 mgm. phytic acid phosphorus in oatmeal and 120 mgm. in national wheatmeal flour; and this is not the end of the story.

In preparing these products for the consumer, the cook again alters their relative phytic acid content. The oatmeal is boiled as porridge, its small phytase content is destroyed and the phytic acid remains at the same high figure. In the case of wheaten flour, the matter is different. The high phytase content gets a chance of destroying phytic acid in the flour during the period when the dough is standing. In this process, however, the flour phytase is not the only phytase present. The added yeast is also rich in this enzyme, and it may, under some conditions, assist the hydrolytic breakdown of phytic acid. Whether it does so assist seems to depend on the method of bread-making adopted. If the amount of yeast added is relatively large (2·1 per cent of flour) and the time of standing of the dough short (2 hours), the yeast may add largely to the phytic acid destruction. If, however, the yeast added is small (0·6 per cent of flour) and the dough rising-time long (6 hours), the yeast phytase may be ineffective. The phytase action of both flour and yeast is greatly increased as the $p$H is lowered towards 4·5, and it is possible that the additive effect of the larger amount of yeast may be partially or wholly explained by this change in $p$H. The accompanying results obtained on baking bread with flour at two levels of phytic acid content illustrate this effect of yeast.

HYDROLYSIS OF PHYTIC ACID IN BREAD-MAKING

| | Mgm. phytic acid phosphorus | | | |
|---|---|---|---|---|
| | Wheat-meal flour per 100 gm. | In bread per 100 gm. flour | Hydrolysed by phytase in 100 gm. flour | Probably hydrolysed by yeast per 100 gm. flour |
| SPECIMEN 1 | | | | |
| (a) High yeast; short rising time: | | | | |
| (x) living yeast | 75 | 29 | 25 | 21 |
| (y) dead yeast | 75 | 50 | 25 | 0 |
| (b) Low yeast; long rising time: | | | | |
| (x) living yeast | 75 | 26 | 46 | 3 |
| (y) dead yeast | 75 | 29 | 46 | 0 |
| SPECIMEN 2 | | | | |
| (a) High yeast; short rising time: | | | | |
| (x) living yeast | 174 | 77 | 76 | 21 |
| (y) dead yeast | 174 | 98 | 76 | 0 |
| (b) Low yeast; long rising time: | | | | |
| (x) living yeast | 174 | 60 | 114 | 0 |
| (y) dead yeast | 174 | 57 | 117 | 0 |

High and low yeast = 2·1 per cent and 0·6 per cent respectively.
Short and long rising time = 2 hours and 6 hours respectively.

Finally, it may be asked, what are the nutritional implications of this phytic acid–phytase problem of cereals? In the normal high cereal diet, three situations are presented: (1) when it contains much phytic acid, as when oatmeal or maize meal is largely eaten; (2) when it contains much inositol and phosphoric acid produced by hydrolysis of phytic acid by phytase, together with some unhydrolysed phytic acid, for example, when bread made from high extraction flour is eaten; (3) when it contains but little phytic acid or hydrolysed phytic acid, as when bread from low extraction flour or when a cereal such as rice is eaten. Since both inositol and phosphate are essential constituents of the diet, it is clearly desirable to have good supplies of these in the food, that is, conditions (1) and (2) above, but only so long as (*a*) these substances are available to the body and (*b*) neither phytic acid nor its product phosphoric acid is allowed to exert its calcium-stealing influence. Both these necessary conditions can be obtained by increasing the calcium in the diet and by maintaining a sufficiently high vitamin D intake. Man, especially the Scot, instinctively found the answer to this problem in the case of oatmeal by taking milk freely with his porridge. That is also the *raison d'être* for the present practice of adding calcium carbonate to the modern loaf and vitamin D to the margarine, although it is probable that, in both cases, the present supplements are too small for the optimum calcium-phosphorus nutrition of many people.

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Aug. 25.

[1] McCance, R. A., and Widdowson, E. M., *Nature*, 153, 650 (1944).
[2] Mellanby, E., *Spec. Rep. Ser. Med. Res. Coun., Lond.*, No. 93 (1925).
[3] Harrison, D. C., and Mellanby, E., *Biochem. J.*, 33, 1660 (1939).

## Catelectrotonic Potentials in the Dorsal Roots of the Spinal Cord

THE preparation has been the isolated oxygenated spinal cord of the frog. It is well known[1,2] that a dorsal root volley gives rise to a prolonged negative potential which is propagated electrotonically from the spinal cord along that root and also along other dorsal roots both ipselateral and contralateral. In adjacent ipselateral roots this dorsal root potential may be as large (10 mV.) as in the root of entry.

With submaximal volleys the dorsal root potential rises to a rounded summit in about 20 msec. and then decays approximately exponentially with successive half-times of about 30–60 msec. With larger volleys there is usually a prolonged negative 'tail' which is attributable to long-continued activity of the internuncial neurones of the spinal cord, and is paralleled by prolonged after-discharge from the motoneurones. In conformity with this explanation, the tail is increased in size and duration by rapid repetitive stimulation and after soaking the cord in strychnine (1 in 200,000).

An antidromic volley in the ventral root fibres also sets up in adjacent dorsal roots a prolonged negative potential which has a longer latent period and a slower rise to a more flattened summit, but which decays at least as rapidly as the dorsal root potential set up by a dorsal root volley (half-times 25–45 msec.). This decay is always exponential, and never shows any prolonged tail.

If the spinal cord is anæsthetized by soaking in nembutal solutions, the rising phases of both types of dorsal root potential are not appreciably altered, but the decaying phases of both are greatly prolonged. Moreover, the abolition of activity in the internuncial neurones is associated with a removal of the tail of the dorsal root potential set up by dorsal root volleys (single or repetitive), which consequently now decays in a strictly exponential fashion, closely resembling the decay of the dorsal root potential set up by the ventral root volleys. The 'half-times' are lengthened 10–20 times by 1 in 7,000 nembutal, ranging with this latter dose between 0·4 and 0·7 sec. Further increase in dosage abolishes the dorsal root potential set up by ventral root volleys.

The exponential time course of the decay suggests that, as with the synaptic potential produced in the motoneurones[3], the dorsal root potential is produced by the relatively brief action of an actively depolarizing agent, the decaying phase of the dorsal root potential being relatively passive (except for the internuncial activity) and governed by the electric time constant of the membrane being depolarized. This analysis of the dorsal root potential into active and passive phases is supported by the effect of nembutal, which (apart from the removal of any internuncial activity) can be simply explained as due to a lengthening of the time constant of the membrane. This time constant is a product of impedance and capacity, and since the capacity of living membranes is but little altered even during extreme changes in the time constant[4], it seems likely that nembutal produces a large (10–20-fold) increase in the electric impedance of the membrane. It has long been suspected that anæsthetics act in this way[5,6]. However, in the spinal cord this effect appears to be largely restricted to certain membranes; for the electric time constant of the motoneurones remains short even under deep nembutal anæsthesia, the half-time for the synaptic potential being about 25 msec. in the frog[3].

The location of the membranes responsible for the dorsal root potential has been investigated by setting up a maximum volley in a dorsal root at all phases of a dorsal root potential produced in that root by a previous volley in that or another dorsal root, or a ventral root. There is an immediate destruction of a large fraction of the dorsal root potential in that root (usually 50–90 per cent, but with some roots as small as 20 per cent), but no effect on the dorsal root potentials in other roots.

On the basis of these experiments, it is suggested that the dorsal root potential is a catelectrotonic potential set up in the central terminals of the dorsal root fibres by the actively depolarizing action of potentials produced in nerve cells in close proximity, particularly in synaptic contact. With the dorsal root potentials set up by dorsal root volleys, the time course of the actively depolarizing action (determined by analysis) is such that it could be produced by the synaptic potentials set up in those nerve cells by the dorsal root volley. This suggestion would explain the extensive distribution up and down the cord of the dorsal root potential produced by a volley in one dorsal root. The decay of the dorsal

root potential would be governed by the time constant of the membrane of the terminal nerve fibres of that dorsal root, and it would be these terminals that are specifically affected by nembutal. The partial destruction of the dorsal root potential by a maximum volley in that root suggests that the impulses do not penetrate to all the central terminal nerve fibres of that root. This suggestion recalls the findings of Renshaw[6] and Lloyd[7] that an antidromic impulse in a ventral root fibre may fail to spread over the surface of the motoneurone of that fibre, block apparently occurring at the axon hillock.

John C. Eccles.

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June 27.

[1] Barron, D. H., and Matthews, B. H. C., *J. Physiol.*, **92**, 276 (1938).
[2] Sonnet, V., and Bremer, F., *Compt. Rend. Soc. Biol.*, **127**, 806, 812 (1938).
[3] Eccles, J. C., *Nature*, **153**, 432 (1944).
[4] Cole, K. S., and Curtis, H. J., *J. Gen. Physiol.*, **22**, 649 (1939).
[5] Osterhout, W. J. V., "Injury, Recovery and Death in relation to Conductivity and Permeability" (Philadelphia, 1922).
[6] Renshaw, B., *J. Neurophysiol.*, **5**, 235 (1942).
[7] Lloyd, D. P. C., *J. Neurophysiol.*, **6**, 143 (1943).
[8] Guttman, R., *J. Gen. Physiol.*, **22**, 567 (1939).

## Mechanism of Burrowing in *Arenicola marina* L.

If a living lugworm is put on the surface of wet sand or mud, it curves its head downwards and burrows in. During the burrowing act (which was described in detail by Just[1]), the proboscis is extruded and withdrawn, wave-movements of a characteristic kind travel forwards along the body, and the notopodia are directed backwards.

According to many authorities, the lugworm swallows sand as it burrows. Thus Stannius[2] wrote: "Legt man eine ausgegrabene Arenicola auf eine von Seewasser etwas bedeckte sandige Stelle des Ufers, so fängt sie alsbald an, eine Röhre im Sande sich zu bohren. . . . Die Röhren entstehen aber nicht ausschliesslich dadurch, dass die Würmer den Sand oder den Schlamm an die Seite drücken, sie verschlingen vielmehr beim Bohren beständig Sand; der ganze Darmkanal wird davon angefüllt, und ehe der hinterste Theil des Thieres die Oberfläche des Bodens ganz verlässt, wird der verschluckte Sand durch den After wieder entleert." Ashworth[3] concludes a description of burrowing with the words "By these means, a passage is eaten and forced through the mud".

When those passages were written, the mode of life of the lugworm was not well understood. In particular, burrowing and feeding were supposed to be one and the same process. More recent work, however, indicates that the two are quite distinct[4]. The worm is now believed to excavate an *L*-shaped gallery, and to lie with its head at the blind end, eating the surrounding mud. I therefore made the following experiments, to find out whether significant amounts of sand or mud are in fact swallowed during burrowing.

(1) *Weighing experiments.* Lugworms were first weighed, then allowed to burrow until only the tip of the tail could still be seen, then dug out and weighed again. The anus was watched, and, if the worm defæcated during burrowing, that particular experiment was discarded. Usually, however, defæcation did not occur. Of the successful experiments, two were done on the beach at Bangor, the worms being allowed to burrow as soon as they were dug up, and the rest in the Department of Zoology of the University of North Wales, using muddy sand from the beach. Generally there was a very slight loss of weight during burrowing (see table). The density of the wet, muddy sand was about 1·9, so it seems that significant amounts cannot have been swallowed.

| Situation | Worm No. | Weights (gm.) Before burrowing | After burrowing | Difference |
|---|---|---|---|---|
| Beach | 1 | 4·0 | 3·8 | —0·2 |
| | 2 | 7·5 | 7·3 | —0·2 |
| Laboratory | 3 | 3·8 | 3·8 | 0·0 |
| | 4 | 7·0 | 6·9 | —0·1 |
| | 5 | 8·2 | 8·1 | —0·1 |
| | 6 | 12·3 | 12·3 | 0·0 |

(2) *Dissection experiments.* Five worms were kept in clean sea water in the laboratory for from three to four weeks. Three of them were then allowed to burrow into sand from the beach, as described above, then dissected under 8 per cent magnesium chloride, which acts as a narcotic[5]. The other two were dissected without preliminary burrowing. In the two controls, there was no trace of sand in any part of the gut. In the worms which had burrowed, small amounts of sand were found in the œsophagus, but there was none in any other part of the gut. One of the three had a single, minute mass of sand, comprising only some half-dozen sand-grains; the second had a single, compact mass, 2–3 c.mm. in volume; and the third had most of its œsophagus incompletely filled with a cylinder of sand. In all cases, the amounts ingested were negligibly small, compared with the volume of a whole worm.

Clearly, the idea that Arenicola passes through the sand like an animated cork borer is fallacious. Burrowing is achieved by thrusting the sand, or mud, aside; very little, if any, is taken in through the mouth. The proboscis is used in burrowing, and also, presumably, in feeding[6], so it appears to be capable of widely different types of action.

In conclusion, a note may be added about the remark of Stannius[2], quoted above, that defæcation accompanies burrowing. I saw defæcation during burrowing in two of four worms on the beach, and never in the laboratory. The worms used in the laboratory had been kept in clean water for a couple of days at least, and had partly or completely emptied their intestines. I think it likely that the defæcation occurs only in replete worms, as a pressure effect of some kind incidental to burrowing. Perhaps those which defæcated would shortly have done so in any case, even if they had not been disturbed.

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July 23.

[1] Just, B., *Z. vergl. Physiol.*, **2**, 155 (1925).
[2] Stannius, H., *Muller's Arch.*, 352 (1840).
[3] Ashworth, J. H., "*Arenicola*", *L.M.B.C. Memoirs*, XI (1904).
[4] Thamdrup, H. M., *Medd. Komm. Havundersøg.*, Kbh., **10**, 2 (1935).
[5] Ledingham, I. C., and Wells, G. P., *Nature*, **150**, 121 (1942).
[6] Wells, G. P., *J. Exp. Biol.*, **14**, 117 (1937).

## Sewage Bacteria Bed Fauna in its Natural Setting

It has been observed that the bacteria beds of sewage works form an environment for insects unlike anything in Nature[1]. The depth of the habitable zone is great, so that compared with most insect habitats it is almost like the cube against the square. It is well aerated and constantly supplied with a basic food supply both in solution and in finely divided form evenly spread over the bed. The temperature is protected from extremes, on one hand by the heat generated by vital processes and on the other hand by the effects of evaporation. The daily temperature swing is restricted. Larvæ and pupæ are not accessible to birds except at the surface. This insect fauna is characterized by the small number of successful species and the great prevalence of those few which do succeed. In eight years of trapping on the Knostrop beds at Leeds, more than half a million insects were caught and scrutinized; and, though in all about a hundred species were taken, 99·7 per cent of the total belonged to six species of nematocerous flies, namely, *Metriocnemus longitarsus*, *M. hirticollis*, *Spaniotoma minima*, *S. perennis*, *Psychoda alternata* and *P. severini*. The enchytraeid worm, *Lumbricillus lineatus*, has an abundance equal to, or perhaps surpassing, that of any of these larvæ in the Knostrop beds. At some works, though not at Leeds, *Psychoda cinerea* and *Anisopus cinctus* show a similar prevalence. The collembolan *Achorutes viaticus* and the cordylurid fly *Spathiophora hydromyzina* are the only other insects so far recorded as prevalent in the beds.

I have recently located this fauna almost intact, though mingled with a number of other successful forms, in the natural setting of a mud flat about four miles from the nearest sewage works. A small, slightly contaminated stream passes under a bridge and, as an effect of an eddy, forms a mud flat about thirty yards long and fifteen yards wide with a surface usually an inch or two above water level. It is constantly water-logged through seepage, but is rarely flooded and then only for brief periods after heavy rainstorms, for there is a sill a short distance downstream giving a rapid recovery to normal level. It is overhung by trees and receives in autumn a thick carpet of leaves which is absorbed into the mud in winter and largely disintegrated by summer. Samples of the surface mud taken to the laboratory have yielded 1,500 insects, of which 44 per cent belong to eight of the ten species enumerated above as forming the insect fauna of the bacteria beds, Achorutes and Spathiophora only having not appeared in the cultures. Of the others emerging, 31 per cent is shared equally between the blood-sucking genus Culicoides and the short-palped crane-flies, Limoniinæ, both of which have very rarely appeared in collections from the bacteria beds. The characteristic enchytraeid worm of the sewage bed, *L. lineatus*, also occurs in the mud flat, but in numbers is almost masked by a swarming tubificid worm densely clustered just below the surface.

Thus it appears that the macrofauna of the bacteria bed is derived from that of the organic mud flat, but the two types of environment are not much alike. The mud flat, however, does rather resemble the sand sewage filter. In this a bed of porous sand some four feet deep is flooded at frequent intervals with settled sewage which seeps through and is purified in passage. A mat of cellulose and other débris forms on the surface, and when this has thickened and dried it can be rolled off like a carpet, leaving the filter again porous and receptive to further dosing.

This discovery of the bacteria bed fauna in its natural setting should help in the study of its theoretical aspects which hold much of interest, especially in regard to animal competition[2,3,4]. It is also of practical interest since the invasion of dwellings by sewage flies is often a matter of concern to sanitary authorities and it is important to know from what other sources they may come.

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The University,
Leeds, 2. Aug. 16.

[1] Dyson, J. E., and Lloyd, Ll., *J. Proc. Inst. Sewage Purification*, Pt. 2, 28 (1933).

[2] Lloyd, Ll., Graham, J. F., and Reynoldson, T. B., *Ann. App. Biol.*, 27, 122 (1940).

[3] Lloyd, Ll., *Ann. App. Biol.*, 30, 47 (1943)

[4] Lloyd, Ll., *Ann. App. Biol.*, 30, 358 (1943).

## Imperial Forestry Institute, Oxford

In commenting in *Nature* of July 15, p. 94 on the 1942–43 report of the Imperial Forestry Institute, it is stated that there is difficulty in distinguishing between the respective parts played by the Imperial Forestry Institute and the University Department or School of Forestry. This is simply explained by the fact, set out at length in the 1937–38 report, that in 1938 they became a single organization supported jointly by the Colonies, the Forestry Commission, the University of Oxford and a few smaller contributors. At the same time, the information branch of the Institute was taken over by the Imperial Agricultural Bureaux to constitute a new Imperial Forestry Bureau which still works in close collaboration with the Institute. This latter change resulted in a transfer to the Bureaux of nearly all the original Dominion support for the Institute, leaving the Colonial Empire in a still more predominant position among the supporters of the Institute.

The amalgamation of School and Institute was made primarily for administrative reasons and to fit in with the new arrangements for the training of officers for the Colonial Forest Service; it did not affect the research work being done by the staff. This latter work continues to be directed towards Empire needs and interests so far as is possible in Great Britain. In several fields, however, for example sylviculture, there is not a great deal having a direct bearing on Empire forestry that can be done in Britain. Research in these subjects is accordingly directed more towards fundamental problems and problems representative of types likely to occur anywhere, and it has to be carried out in the woods and forests accessible from Oxford. Such studies are clearly likely to be more productive and useful if undertaken in co-operation with the related research activities of the Forestry Commission.

From the educational point of view, it is essential, for keeping the teaching live and practical, that the staff should be in the closest possible touch with current practice and developments where the teaching is done. Moreover, the Forestry Commission looks to Oxford, as having the only University Forestry School in England, to play its part and undertake its share in forestry education for service at home as well as abroad, and in forestry research of a fundamental nature. It was for these reasons that

it was felt desirable to await the publication of the Forestry Commission's plans before deciding on some aspects of the future teaching and research organization at the Institute. If the stress in the report appears to be on the importance of closer co-operation in research with the Forestry Commission, this was only because there appeared to be room for it, whereas decisions affecting Colonial forestry had already been agreed. The expected White Paper has since been published; it was considered by the University Committee for Forestry, which found that no further changes in its own plans were necessitated.

This opportunity may be taken to add that forestry has recently been made an Honour School in this University, as from the next academic year; two years study of biological and physical science will normally be required before the two years forestry courses are undertaken, as was already the position under the statute of 1938.

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## Structure of Cellulose

IN their criticism of my suggested structure of cellulose[1], Astbury and Davies[2] appealed to evidence not then available to me in a thesis by Dr. C. J. Brown[3]. My thanks are due to Dr. Astbury for bringing this interesting work to notice and to Dr. Brown for the opportunity to read it. I do not think that it settles the issue between the angles 110° and 90° at the oxygen of the pyranose ring. The difference amounts to $\pm 0 \cdot 15$ A. in the *b* co-ordinate of C1 and C5 respectively, whereas the author, rather modestly, claims only an accuracy of $\pm 0 \cdot 4$ A. The features referred to by Astbury and Davies describe a regular six-sided figure—I presume they would not suggest that this is a precise description.

In "the most detailed saccharide crystal analysis so far reported", Cox and Jeffery[4] conclude in favour of a slightly flattened form of the Sachse *trans* form. This is the form I adopt and, moreover, the strainless arm-chair form, though Dr. Astbury does not appear to recognize it nor appreciate its comfort. In these, as in other studies, reasonable agreement is found with forms based on the 110° assumption, but it remains to be proved that the error in a trial of 90° must be significantly greater.

Meyer and Misch[5] also assume 110°, but I cannot reproduce their parameters from their geometrical assumptions. A unit of length to fit into the 10·3 A. identity period can be obtained by assuming a regular ring of bonds of length 1·50 A. (mean of 4 C–C and 2 C–O bonds) but this is too crude an approximation. My calculations of the rigorous form, with the screw axis as shown by Meyer and Misch, give a length of 11·12 A. (Curiously enough this is longer than it would be if the ring were a regular figure of 1·54 A. bonds.) With another choice of axis, the chain might be buckled into the cell, but I have been unable to find a probable form in conformity with the geometry and with the clearest features of the X-ray diffraction, from the ($h$ 0 $l$) zone.

Cox[6] recognizes that the form of the molecule may be modified by intermolecular forces. This consideration should modify any dogmatism about the unknown form of the cellulose ring, but it does not seriously affect the power of his elegant argument for a nearly co-planar arrangement of the sugar ring carbons[7].

It must be admitted that direct evidence to decide between 90° and 110° for the oxygen angle in the cellulose ring is lacking. If Astbury and Davies, Cox and Brown, Meyer and Misch, Haworth and others assume an unstrained angle of 110°, they may do so in good company—but Pauling[8] as well as Peirce must be excluded from the company.

The variation of the oxygen angle shows it to be deformable. If one sees an elastic thread under an evident load, it is no speculation to assume that its unstrained length is less than the observed length. In $H_2O$, the oxygen angle is 105° and it is distended by the ionic character of the H fields. This ionic character is less in $F_2O$ and the angle is less, 100°. In $H_2S$, the greater separation of the H fields means less repulsive stress and the angle is 92°. (These are the values quoted by Pauling[8].) When large groups are attached to the two bonds, the angle is correspondingly large, attaining 130° and more in the diphenyl ethers[9,10]. All this is in perfect accord with Pauling's theory, that the oxygen bonds arise from *p* electrons and are unstrained at 90°.

It is true that atoms of the appropriate size to enforce an angle of some 110°, Cl (in $Cl_2O$) and C, are not infrequently involved, but this obviously strained angle of a soft atom is not to be confused with the tetrahedral angle of the hard and symmetrical carbon atom. The latest figures on the aliphatic ethers give values of 110° or less[11], and these are clearly strained by an otherwise unbalanced repulsion between the closely held carbon atoms. Dioxane (110°)[12] looks more like a pyranose ring but, by symmetry, the field round each oxygen atom must be closely similar to that in dimethyl ether. When the two carbon neighbours of the oxygen are held also by a line of three carbon atoms, these can take some of the stress from the oxygen bonds and even impose an opposite strain, if there be a minimum of free energy when a line of carbon atoms is co-planar.

The position seems to be, therefore, that the unstrained angle is 90° and the strain is unknown—so the simplest assumption is the strainless form, as given in my note. The fact that it fits so neatly into the cellulose lattice commends it, but I would be the last to claim for the resultant structure any status beyond that of a tentative, approximate speculation, possibly useful as a working hypothesis to correlate the general body of data: and this is all that I would allow to any detailed crystal structure ascribed to a macromolecular fibre.

The parameters are given to 0·01 A. because they express the geometrical consequences of assumptions reasonably defined to that degree of accuracy. This basic, strainless form may later be strained to accord with direct evidence still to be found, but it seems worthy of inclusion in 'trial and error' studies. To that end, it was offered through the speedy channel of the correspondence to *Nature*.

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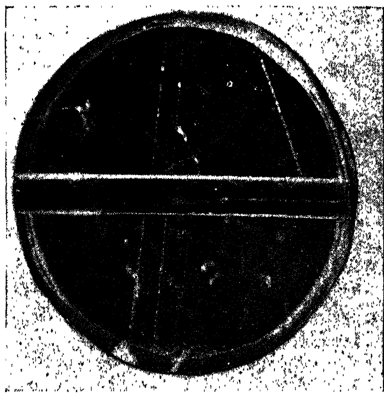
[1] Peirce, *Nature*, **153**, 586 (1944).
[2] Astbury and Davies, *Nature*, **154**, 84 (1944).
[3] Brown, C. J., Ph.D. Thesis (Birmingham, 1939).
[4] Cox and Jeffery, *Nature*, **143**, 894 (1939).
[5] Meyer and Misch, *Helv. Chim. Acta*, **20**, 894 (1937).
[6] Cox, *Nature*, **154**, 84 (1944).
[7] Cox, Goodwin and Wagstaff, *J. Chem. Soc.*, 1495 (1935).
[8] Pauling, "Nature of the Chemical Bond", p. 78 *et seq.* (1939).
[9] Sutton and Coop, *J. Chem. Soc.*, 1869 (1938).
[10] Hampson, Farmer and Sutton, *Proc. Roy. Soc.*, **143**, 147 (1933).
[11] Sutton, *Ann. Rep. Chem. Soc.*, 72 (1940).
[12] Glasstone, *Ann. Rep. Chem. Soc.*, 84 (1936).

## Cloud Chamber Photographs of Penetrating Showers

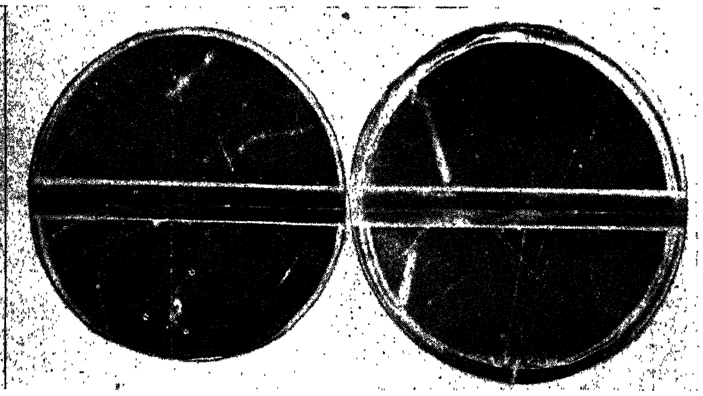
In a long series of counter experiments, Wataghin, de Souze and Pompia[1], and Jánossy[2] and his co-workers have established the existence of showers of penetrating particles different from electron cascade showers and knock-on showers. It now seems probable that the theory of cosmic-ray mesons put forward recently by Hamilton, Heitler and Peng[3] can account satisfactorily for these showers in terms of mesons (and neutrettos). These particles are assumed to be created by protons (or neutrons), of energies greater than $2 \times 10^9$ eV. by cascade or multiple processes.

More direct confirmation of this interpretation of the experimental results is desirable, and for this reason we have recently set up a cloud chamber controlled by a set of counters which selects penetrating showers. The counter sets are arranged in three trays and are connected in sevenfold coincidence such that 95 per cent of all coincidences are caused by penetrating showers. The middle and bottom trays are surrounded by lead 15 cm. in thickness, and the total vertical thickness of lead is 53 cm. Electron cascade showers are thus effectively cut out. The top tray is covered with lead 5 cm. in thickness, and the cloud chamber is placed between the middle and bottom trays.



1

Fig. 1. An example of a shower of penetrating particles produced by a multiple process. Three particles can be seen passing through the lead plate.



2*a* 2*b*

Fig. 2. Two examples of showers of penetrating particles produced by a cascade. In (*a*), two particles can be seen to pass through the lead plate, whereas in (*b*) three (and possibly four) particles pass through the plate.

Some thirty photographs have been obtained so far, and of these, eighteen photographs show penetrating particles which pass through a lead block, 2·3 cm. in thickness, without multiplication. Nine of the eighteen photographs show showers consisting of two or more penetrating particles.

The results are consistent with the assumption that almost all penetrating showers contain ionizing penetrating particles. Further, they show that the ionizing particles themselves are penetrating, and are not soft ionizing secondaries to a non-ionizing penetrating radiation. The ionizing penetrating particles may, however, be accompanied by non-ionizing particles (for example, neutrettos).

Showers of two main types occur among the nine photographs. The first type, typical of almost all the published photographs of showers of penetrating particles, consists of penetrating particles originating at one point, that is, particles produced by a multiple process. Jánossy[2] has shown that these showers are to be expected from the theory of Hamilton, Heitler and Peng if the incident proton (or neutron) has an energy between $2 \times 10^9$ eV. and $2 \times 10^{10}$ eV. An example of this type of shower is reproduced in Fig. 1.

The second type of shower, two examples of which are reproduced in Fig. 2, consists of penetrating particles coming from different directions. It seems probable that this type of shower is an example of the production of penetrating particles by a cascade process[3,4].

Bose, Choudhuri and Sinha[5] have recently published a photograph which they claim shows the production of mesons by a cascade process. To establish such a claim it is first necessary to prove that the shower is not an electron cascade, for electron cascade showers are very frequent while penetrating showers are rare; and it is insufficient to state that the shower contains mesons. Moreover, the one group of particles on Sinha's photograph which clearly passes through the lead plate in the cloud chamber emerges accompanied by several electrons. It is assumed that these are knock-on electrons produced by mesons, but this is very unlikely as the chance of a number of mesons producing several knock-on electrons is negligibly small. The multiplication of the particles in passing through the lead plate is, in fact, a clear indication that they are electrons and not mesons.

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[1] Wataghin, G., de Souze, M., and Pompia, P. A., *Phys. Rev.*, **57**, 61, 339 (1940).
[2] Jánossy, L., *Phys. Rev.*, **64**, 345 (1943).
[3] Hamilton, J., Heitler, W., and Peng, H. W., *Phys. Rev.*, **64**, 78 (1943).
[4] Peng, H. W., *Proc. Roy. Irish Acad.*, **49** A, 245 (1944).
[5] Bose, D. M., Choudhuri, B., and Sinha, M., *Phys. Rev.*, **65**, 341 (1944).

## Volcanic Contributions to the Atmosphere and Ocean

If it be assumed, as is now again the fashion, that the nascent earth passed through a liquid stage, it is obvious that "the molten spheroid . . . retained, occluded within itself, some large part of the water in the present hydrosphere, as well as much of the carbon dioxide represented by the present carbonates and carbonaceous deposits"[1]. Most of the carbon dioxide that has become available as a source of

carbon is undoubtedly of volcanic origin, being derived from magma.

A useful estimate of the amount of carbon that has been extracted from the atmosphere by various means has been made by Poole[2], who, however, has unnecessarily revived the theory that this has been all present at one time in gaseous combination in a 'primitive' atmosphere. Poole assumes that some of the fixed carbon has been derived from methane so present instead of from carbon dioxide—an assumption he has considered necessary because of an apparent over-supply of the by-product oxygen if carbon dioxide were the sole (or greatly predominant) source of carbon. When, however, oxidation of juvenile hydrogen throughout the long history of volcanic activity is taken into account, there is no longer any difficulty in accounting for the disposal of such an apparent surplus of atmospheric oxygen. A supply of oxygen for this purpose must indeed be found if there is anything of value in the theory of the volcanic furnace. It is permissible, and indeed necessary, therefore, to recalculate Poole's estimate of atmospheric methane as carbon dioxide, a more likely atmospheric gas.

When this is done, the total mass of carbon dioxide is $7 \cdot 02 \times 10^{16}$ metric tons; and to this must be added $0 \cdot 4 \times 10^{16}$ metric tons of nitrogen now in the atmosphere, and also $0 \cdot 18 \times 10^{16}$ metric tons of juvenile hydrogen which has combined with the surplus of oxygen liberated from carbon dioxide, giving a total of $7 \cdot 6 \times 10^{16}$ metric tons of gases in what must be regarded as the primitive atmosphere (itself perhaps very scanty) *together with the gases that have been emitted from volcanoes throughout the history of the earth*. This excludes juvenile water vapour, which it is impossible to estimate by this method; it has undoubtedly made a substantial contribution to the ocean, however. For comparison, the mass of the atmosphere at present, as given by Poole, is $0 \cdot 52 \times 10^{16}$ metric tons.

One great advantage of recognition of the juvenile (magmatic) origin of carbon, as compared with the 'primitive atmosphere' theory, is that it is in agreement with the geological doctrine of uniformitarianism. If one is to understand that doctrine in a forward-looking sense, a continuance of the supply of carbon from volcanoes will make possible the accumulation of further deposits of coal and limestone in the thousands of millions of years of future geological time; whereas in accordance with the 'primitive atmosphere' theory the supply of carbon for this purpose is exhausted, geological processes have worked themselves to a standstill, and we have arrived at the end of the world.

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[1] Chamberlin, T. C., and Salisbury, R. D., *Geology*, **2**, 90 (1906).
[2] Poole, J. H. J., *Sci. Proc. Roy. Dublin Soc.*, **22**, 345 (1941).

## The Deflexion of Light and Relativity

IN a recent paper, E. F. Freundlich and W. Ledermann[1] have pointed out that "the question remains unsettled whether the light deflection at the sun's limb amounts to $1 \cdot 75''$ as predicted by the Theory of Relativity or whether it is substantially larger, namely, equal to $2 \cdot 2''$ as indicated by the findings of the Potsdam Expedition of 1929 and confirmed by a renewed discussion of previous observational material". The authors then proceed to discuss how an experiment can be planned to settle the question so that the standard deviation of the final result does not exceed $0 \cdot 1''$.

If $m$ is the solar mass and $R$ the radius in natural units, $4m/R$ is the predicted deflexion[2]. But $2 \cdot 2''$ means $5m/R$. As the deflexion provides a crucial test of the theory, the question that is often asked is whether relativity must be modified to give the result $5m/R$ instead of $4m/R$. It is well known that the Newtonian result, $2m/R$, is obtained from the usual equation,

$$\frac{d^2u}{d\varphi^2} + u = \frac{m}{h^2}; \tag{1}$$

and the relativistic result from

$$\frac{d^2u}{d\varphi^2} + u = 3mu^2. \tag{2}$$

For particles moving *almost* with the velocity of light, we have

$$\frac{d^2u}{d\varphi^2} + u = \frac{m}{h^2} + 3mu^2, \tag{3}$$

and the deflexion, small as it is, is

$$\frac{2m}{Rv_0^2} + \frac{4m}{R}, \tag{4}$$

where $v_0$ is the velocity, $Rd\varphi/ds$, at the perihelion. For light $v_0 = \infty$. The range $1 \leqslant v_0 \leqslant \infty$ corresponds to the velocity $Rd\varphi/dt$ lying between $0 \cdot 70c$ and $c$. The deflexion is $5m/R$ for a particle for which $v_0 = \sqrt{2}$ and $Rd\varphi/dt$ is $0 \cdot 82c$. In the Newtonian theory there is no distinction between $dt$ and $ds$, and hence $v_0 = 1$ for light, but the second term of (4), which is of relativistic origin, is absent.

If the deflexion is really $2 \cdot 2''$, one wonders if fast moving atomic particles, with velocities of the order of $0 \cdot 8c$, participate in the process leading to the observed result.

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Aug. 13.

[1] Freundlich, E. F., and Ledermann, W., *Mon. Not. Roy. Ast. Soc.*, **104**, 40 (1944).
[2] Eddington, Sir A. S., "The Mathematical Theory of Relativity", 90 (1924).

## The Commutation of Annual Subscriptions

MOST learned societies allow future annual subscriptions to be commuted by single payments which range from five to twenty-five times the annual subscription with, in many cases, a reduction to members of long standing. Although this is usually advantageous to the younger members, it is too expensive at later ages when there is most interest in commutation. There has thus arisen a growing demand for commutation scales on an actuarial basis.

Some examples of such scales may be given. The Institute of Actuaries, with an annual subscription of 3 guineas ceasing at the age of seventy, requires a payment of 30 guineas at age forty-five, with 1 guinea less for each additional year of age up to sixty and then by steps of $1\frac{1}{2}$ guineas to a minimum of $7\frac{1}{2}$ guineas at sixty-five and over. The actuarial basis of this scale is not stated, but the amounts appear to be two thirds of those derived from a $3\frac{1}{2}$ per cent annuity table.

The Royal Society now permits commutation on payment of the amount which the fellow would have to pay for a Government annuity on his own life

of the amount of the annual subscription. This varies with the price of $2\frac{1}{2}$ per cent Consols and the basis is a very stringent one, since the amounts payable are those required if fellows had entered into agreements to continue their annual subscriptions for the remainder of their lives.

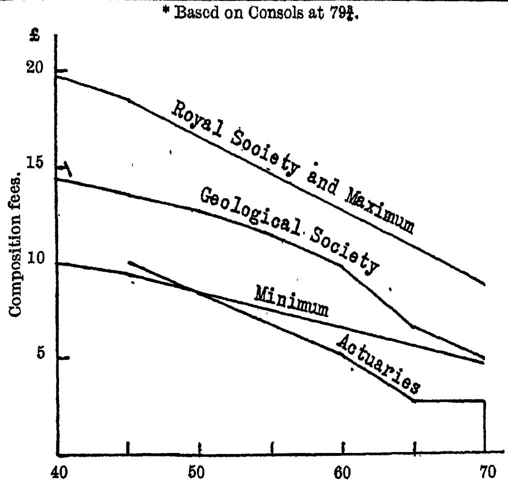
The most elaborate scale is that of the Geological Society of London. The full table contains some thousands of entries; it quotes the commutation fee for each age *at election* from twenty to eighty, combined with each number of annual contributions already paid, from nought to fifty. It does not seem to have been noticed that, in general, age at election plus number of annual contributions already paid equals present age. Apart from a few unnecessary irregularities, the vast table could be replaced by its top line with "age last birthday" substituted for "age at election" or by its first column.

The commutation scales of these societies for ages forty to seventy, all expressed as per £1 of annual subscription, are summarized in the accompanying table and graph, which also give suggested maximum and minimum scales. The maximum scale, which on the graph can scarcely be shown separately from that of the Royal Society, is based on the Mortality of Annuitants, 1900–1920, $a(m)$ 3% Ultimate.

COMMUTATION FEES PER £1 OF ANNUAL SUBSCRIPTION £

| | Age last birthday | | | | | | |
|---|---|---|---|---|---|---|---|
| | 40 | 45 | 50 | 55 | 60 | 65 | 70 |
| Institute of Actuaries | — | 10·0 | 8·3 | 6·7 | 5·0 | 2·5 | Nil |
| Royal Society* | 19·8 | 18·2 | 16·4 | 14·4 | 12·4 | 10·4 | 8·5 |
| Geological Society | 14·3 | 13·5 | 12·7 | 11·1 | 9·5 | 6·3 | 4·8 |
| Suggested maxima | 20·1 | 18·4 | 16·7 | 14·8 | 12·9 | 10·9 | 9·1 |
| Suggested minima | 10·0 | 9·2 | 8·3 | 7·4 | 6·4 | 5·5 | 4·5 |

* Based on Consols at $79\frac{1}{2}$.



Age last birthday (years).

Any society which wishes to institute a scale of commutation fees should, I think, take into account the normal rate of withdrawal from its ranks. The suggested maximum scale, which assumes that withdrawals are impossible, will rarely, if ever, be applicable, and in general some percentage of the maximum should be used. Where withdrawals are rare, the percentage should be nearly 100 per cent, but where withdrawals are more frequent, as in societies the members of which are loosely held together only by a common interest in some field of activity, a lower percentage should be used. It is suggested 50 per cent of the maximum should be regarded as the minimum. Women should pay slightly higher commutation fees, but most societies will ignore this. In selecting a scale, simplicity is more important than adherence to exact actuarial values; in most cases either a single arithmetical progression or possibly two, as used by the Institute of Actuaries, will suffice. Thus the minimum commutation scale for a society with an annual subscription of 5 guineas might be 70 guineas at age twenty-five and decrease by one guinea for each additional year of age to a minimum of 20 guineas at age seventy-five.

What should be done with such commutation fees? Most societies invest the whole of them and transfer to ordinary income only the interest earned; they thus build up useful hidden reserves in their accounts. Some further transfer to ordinary income is, however, reasonable and, in the absence of periodical actuarial investigation, it will in the long run be found satisfactory to transfer to ordinary income, in addition to the interest earned on the commutation fee fund, some small portion of each commutation fee received. This may be, say, one sixth, or alternatively the amount of one annual subscription. Only the balance of each commutation fee would then be invested.

DAVID HERON.

2 The Orchard, Bedford Park,
London, W.4.
Aug. 4.

## Mr. W. L. Sclater

MANY years after his friends—Dr. A. C. Stark, the brothers H. F. and W. Francis and F. C. Selous—had lost their lives by enemy action, W. L. Sclater also fell a victim to enemy action[1]. Sclater was director of the South African Museum from 1896 to 1906. He was appointed director when the new building (the present one) had just been completed, and his was the task of planning the arrangement of the exhibits. In the main his original plan persists, though with the logical alterations and extensions made possible by the addition of a new wing in recent years.

The late Dr. Peringuey was already on the Museum staff as entomologist. Sclater proceeded to assemble, as members of the staff or as honorary curators, a body of scientific workers to undertake research on the Museum collections: the late Dr. W. F. Purcell for invertebrates, the late Dr. Gilchrist for marine biology, the late Dr. Corstorphine for geology, and afterwards Dr. Rogers (happily still with us), and the late Dr. Pearson for botany; he himself took charge of the vertebrates. The acquisition of specimens was extended and accelerated by regular museum correspondents in all parts of the country, and the collections grew at a pace which has scarcely been exceeded in recent years, except in the various groups of invertebrates, even with the Museum's increased staff and facilities for field work.

To him was due the appointment of a promising young taxidermist, Mr. J. Drury of Perth, whose talents reached full fruition only after Sclater had resigned the directorship, and resulted in the unique series of casts of living Bushmen.

K. H. BARNARD.

South African Museum,
Cape Town.

[1] *Nature*, **154**, 204 (1944).

# OCCASIONAL WHITENESS OF THE DEAD SEA

By DR. R. BLOCH and H. Z. LITTMAN
Palestine Potash, Ltd., Jerusalem
and DR. B. ELAZARI-VOLCANI
Daniel Sieff Research Institute, Rehovoth

ON the morning of August 25, 1943, it was observed that the whole Dead Sea, which at this season is always perfectly clear, had become milky white. The same observation was made on the same morning at the northern and southern ends, which are seventy kilometres apart, and it was further ascertained that during that night the whole Dead Sea had turned white. During winter storms a seam of some 100 metres occurs frequently along the shores, turbid and yellowish, but it was never observed that the whole Dead Sea surface had turned white. The turbidity gradually disappeared and in December 1943 the water became almost clear again.

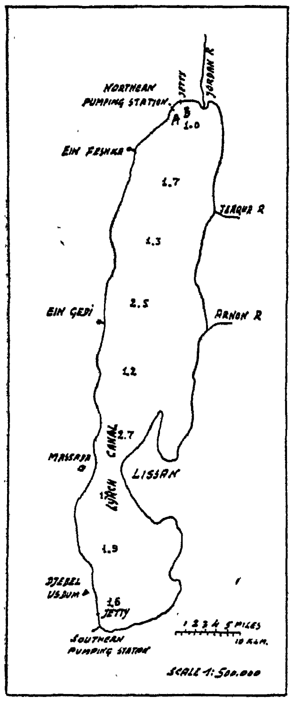



Fig. 1. MAP OF THE DEAD SEA, SHOWING THE RELATIVE TURBIDITY OF THE SURFACE LAYER.

The nephelometric analysis of several water samples taken on October 10, 1943, revealed the distribution of the turbidity as shown in the map (Fig. 1). The numbers represent the relative turbidity, the lowest value taken as unity. Samples at different depths taken at point *A* in the map showed the following relative turbidity:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Depth in metres | .. | 0 | 2 | 3 | 5 | 10 | 15 | 20 | 50 |
| Relative turbidity | .. | 1·3 | 1·2 | 1·1 | 1·5 | 1·9 | 1·1 | $<$1 | clear |

A sample of 30 litres was taken at place *B* and filtered. It contained 0·018 gm./litre of a white solid of which 15 per cent was insoluble in diluted hydrochloric acid, 5 per cent was insoluble in concentrated hydrochloric acid, and 80 per cent was calcium carbonate. Moreover, the turbidity of other samples dissolved readily on adding hydrochloric acid, developing carbon dioxide.

On a rough calculation, one million tons of calcium carbonate seem to have spread over the whole Dead Sea during the night. There is no obvious explanation for this phenomenon. There was only the usual slight wind blowing from both the northern and southern shores towards the centre of the Sea. No earthquake was registered before or after the night in question, and the occurrence of a slight tremor 12 and 16 days later (September 6 and 10) offers no explanation. Dr. M. R. Madwar, director of the Helwan Observatory, Egypt, informs us that no other nearby earthquakes were recorded.

We inquired, therefore, whether the phenomenon which we had witnessed had ever been observed before. The Dead Sea has been under close observation since 1921, when Mr. M. Novomejsky, the founder and managing director of the Palestine Potash Ltd., started his experimental installations and observation posts. During this period no such phenomenon is known to have occurred. In the nineteenth and the early twentieth centuries several scientific men visited the Dead Sea but none of them (Schubert, Russegger, Robinson, Wilson, Welcotts, Seetzen, Castigan, Scott, Molineux, Lynch, Larter, Blanckenhorn) has ever said anything about the Dead Sea being white. When at our suggestion a preliminary survey of Hellenistic literature was made, a quotation from the famous Greek physician Galen, who visited the Dead Sea at about A.D. 158, was found* in his "De Simplicium Medicamentorum Facultatibus"[1], stating that the waters of the Dead Sea "appear at first glance whiter and heavier than all Seas". (το δὲ τῆς ἐν Παλαστίνῃ Συρίᾳ λίμνης ὕδωρ, ἥν ονομάξονσιν οἱ μὲν θάλασσαν νεκράν, οἱ δε λίμνην ἀσφαλτῖτιν . . . κατὰ τὴν ὄψιν εὐθυς ἅμα πάσης θαλάσσης λευκότερον τὲ καὶ παχύτερον φαίνεται.)

As the purpose of Galen's journey was to establish the usefulness of its waters for the preparation of drugs, he must have surely meant that the water itself was white, and not the appearance of the sea at certain hours of the day as Russegger[2] described it in 1815. Thus Galen appears to be so far the only reliable investigator who mentions the Dead Sea as being white, although this place was repeatedly described during the Roman occupation of Palestine. In this connexion it may be worth mentioning that in the Bible (*Genesis*, 14, 3) the sentence occurs: ". . . in the vale of Siddim, which is the salt sea". The word "Siddim" has no connexion with "Sodom", the Hebrew spelling of which is quite different, but could be the plural of the Hebrew "Sid", which means lime. If that be an indication that the Dead Sea was white in Abraham's time, then the following observation might lead to some better knowledge of Biblical times.

We have seen that human records have very little to tell about this outstanding event in the history of the Dead Sea. But we have found much more in the books of Nature.

One of us[3] obtained during December 1941 from the bed of the Dead Sea a number of profiles 10–170 cm. long, from depths varying from 70–330 metres and taken at different places. On dissecting the longest profile a 'spectrum' of layers of different colours—black, dark-blue, grey, brown and white—was revealed.

* Flusser, Hebrew University, Jerusalem, private communication.

The thickness of the distinct white layers is 0·3–6 mm. It is interesting to note that the white zones of sediment form no seasonal repeat pattern. The following table shows the result of analyses of the dry substance of two white layers (Nos. 1 and 2) and of some dark material (No. 3); these were made two years after taking the profile.

| No. | 1 | 2 | 3 |
|---|---|---|---|
| Distance from top of profile (cm.) .. | 38 | 52 | 53–58 |
| Calcium carbonate (per cent) .. .. | 70 | 81 | 38 |
| Insoluble in hydrochloric acid (per cent) | 7 | 3 | 35 |

The identity of colour and chemical composition of the white layers with the material causing the turbidity is striking. We therefore assume that each white layer of the Dead Sea bed is caused by an outbreak of turbidity, and that similar outbreaks occurred earlier and are distinctly recorded on the profile. The dark layers, containing much more silicates, are formed by the mineral materials brought annually into the Dead Sea during the normal periods between outbreaks of turbidity. Hence, an exceptional opportunity is thereby offered to investigate the history of the Dead Sea chronologically, and to detect the time of similar 'blanchings' in history by fixing the thickness of the annual dark sedimentation which settles on the 'white lawn' that has formed during the last outbreak.

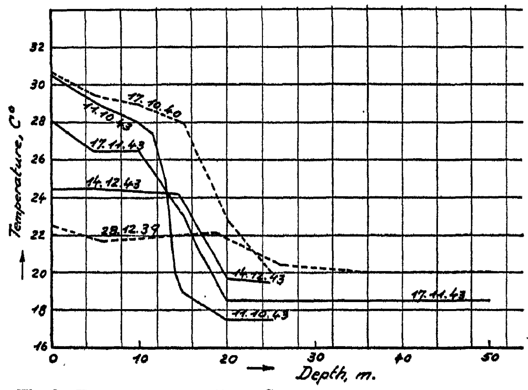



Fig. 2. TEMPERATURE OF DEAD SEA WATER AT DIFFERENT DEPTHS AND TIMES.

Another phenomenon connected with the spontaneous occurrence of turbidity is the change in temperature which took place in the Dead Sea water. It has been assumed that the white colour of the surface water must cause a rise in reflexion of the sun's rays. The assumption was confirmed by measurements of temperature at different depths, which are represented in Fig. 2. We find a difference of as much as 8° C. in October 1943 as compared with October 1940, at the depth of 15 m. below the surface. It is noteworthy that the temperature of deeper strata rose again when the turbidity slowly disappeared. This occurred in spite of the fact that the temperature nearer the surface was then lower owing to the progressing winter season. It is therefore most probable that the lower temperature in 1943 was not caused by fluctuation of atmospheric temperature but by the stronger reflexion of the sun's rays.

It may also be assumed that the lower temperature has caused a corresponding reduction of evaporation, but measurements of the sea-level gave no clear picture, because the quantity of rainfall during the preceding winter season was exceptionally large and evaporation during the first month of 1943 was low. It may, however, be possible to find later on the correlation between the rise of sea-level and the 'blanching' of the Dead Sea and thereby to determine the sea-levels which existed in the past.

We have, of course, tried many explanations for the phenomenon described, but none of them is as yet well enough founded to be of sufficient general interest. Owing to war time conditions, it was unfortunately not possible to make more exhaustive observations and measurements, but it is hoped to clarify some time later the various questions by systematic borings of the Dead Sea bed, and by a careful study of the ancient literature on Palestine and the Dead Sea. We hope that the results will not only be important from geological or even technical aspects, in affording an exact knowledge of sea-levels at different times, but also for students of history and of the Bible, since there is a close link between the Dead Sea and the development of religion.

We wish to extend our thanks to the managing director of the Palestine Potash Ltd., Mr. M. Novomejsky, and to those of the Company's staff, who were helpful with suggestions and measurements, especially to Messrs. Campbell, Cahaner, Shirisly and Schnerb.

[1] Galen, "De Simplicium Medicamentorum Facultatibus", IV, 20; editio Kühn, XI, 690.
[2] Ritter, C., "Die Erdkunde von Asien", 764 V/II, par. 9 (Berlin, 1850).
[3] Elazari-Volcani, B., *Nature*, 152, 274 (1943).

# INDIAN UNIVERSITY ARCHITECTURE

IN a paper read before the Indian Institute of Architects early this year, Nawab Zain Yar Jung Bahadur, chief architect, Hyderabad State, dealt with the design of a residential university, as exemplified in the new Osmania University in Hyderabad. This has been planned on the American campus principle on a site of 1,600 acres, giving ample space for future expansion and the inclusion of well laid-out grounds of impressive dimensions. The author had previously made a fairly thorough study of university architecture both in Europe and the United States, in which connexion he expressed pleasure at the evidence of a master plan in the design of the English universities of Birmingham and Nottingham, but regrets that it is less evident in the case of Edinburgh and Leeds and in most of the Indian universities.

The Osmania University is located in somewhat hilly and picturesque country at Adigmet, a village between Hyderabad and Secunderabad to the north-east of the city, nearly 200 ft. above the level of the city, of which it commands beautiful views. Among the ridges on which the University is being built the highest has been set apart for the senate hall, which is to be a monumental building and the keystone of the whole project. On one side of it is the arts college, already completed, and on the other the library and law college will be built. These will form the central group of the main axis. There are two ridges stretching from the senate hall hill: on the left ridge all the science colleges are or will be located, three of which—physics, chemistry, and biology—are already under construction. The ridge to the right has been reserved for the museum and the training college, the training school, the school of arts and the art gallery. The hostels and dining halls are situated in the loop behind the science

colleges, and the residential area for the teaching staff is beyond the hostels.

In addition to these, sites have been selected for the medical college and hospital, the colleges of agriculture and forestry, the college for women, a students union, a faculty club, a market, a post and telegraph office, botanical garden, stadium, gymnasium, swimming pool, and a colony for subordinates and servants. It is interesting to note, in regard to acoustics, that only large lecture theatres have been given acoustical treatment, and only those rooms where quiet is absolutely essential, owing to the heavy cost of acoustic materials.

One of the main causes of disease in India is said to be the impurity of drinking water; and the question of having separate drinking water for caste Hindus is also a problem for schools and colleges which cannot be ignored. To meet fully the special needs in this respect and minimize risk of infectious disease, modern drinking fountains are being installed throughout.

In regard to style, the author said that in other important countries of the world the science of architecture has made rapid progress, but in India he thinks they are sadly behind the times; and in spite of the money that has been and is being spent on educational institutions, he has seen nothing yet of real architectural value. "In fact some of the buildings are so poorly designed and so badly constructed that they are a blot on the landscape and invoke in the heart an unholy desire to pray for an earthquake or fire." The reigning Nizam, who has taken a keen interest in the new University, expressed the wish that, while possessing all modern facilities, it should have no Western elements in its architecture. Speaking of the arts college at the time of his Jubilee, His Exalted Highness said that "the architecture of this building represents a blending of the Hindu and Muslim styles, and the art and culture of both these races are reflected in the pillars and traceries and carvings on the doors and walls. Thus the building symbolises the close contacts and friendly relations subsisting for centuries between the various classes of my subjects. . . . The Osmania University should not only be a repository of Hyderabad's best traditions, a model of its high culture; it should also aim at broadmindedness and mutual toleration and unity among the students, for in that ideal lies the well-being and the prosperity of this State".

The author has accordingly embodied the Hindu and Muslim cultural elements of all periods in the State, such as the Buddhist, Jain, Brahmanic, Bahmani, Kutub Shahi and Moghal. These have all been blended to form a composite whole, signifying the evolution of a new style which should distinguish His Exalted Highness's reign from all the other rulers in the history of the Asafjahi dynasty.

The arts college which, at the beginning of this year, was the only completed building in the scheme, covers an area of 250,000 sq. ft. and is designed to accommodate two thousand students. It is a two-storied structure, with basement, built entirely of local granite of pink and grey shades, with the inner walls plastered and the outer surface in ashlar masonry. All the rooms are finished in plain white lime plaster, except the entrance hall, where stucco is used. The dome surmounting the entrance hall is about 50 ft. in diameter, resting on corbel slabs. The entrance hall is built in reinforced cement concrete, and is 66 ft. from floor to ceiling. The main roof and intermediate floors and staircases are constructed in reinforced cement concrete. All the floors are paved with polished Shahabad stones from the regions of Tandur and Nawandgi in Hyderabad State, with the exception of the entrance hall, where the floor is red terrazzo. The most difficult and slow part of the work was the process of stone-dressing, as the local granite is of the hardest variety. The stone lintels over the massive columns of the ground floor verandah of the arts college weigh about seven tons each and are 18 in. in span. The stones used for the decorative cornices weigh 2½–3¾ tons each. The complete woodwork (including furniture) of the entire buildings is being carried out in the best Rangoon teak. 4,000–5,000 workmen were engaged during the first year or two of the construction work. In addition to local labour many stone-dressers and artisans were imported from southern towns such as Tanjore, Turkapalam and the Conjivaram, to assist directly with the work and also to train the local workers.

The whole scheme is expected to cost a little over two crores, and the author replies to some criticism on the ground that far too much money is being expended on the new University. Before he had seen some of the world's greatest educational centres he was inclined to agree that the cost should be kept low; but examples in other parts of the world convinced him that the University is a nation-building institution in the best sense of the term; the future of the younger generations and of the State itself will obviously depend on the type of University. It is concluded that if the people of India are to be brought physically and mentally to the same level as those of other civilized nations, it is vital that the new University, and others in India, should be built on the principles accepted and the standards fixed in other countries; and it is quite certain that Hyderabad is a big enough State to think of a big university worthy of itself and of its traditions.

## EAST AFRICAN ARCHÆOLOGY

FIVE distinct types of polished stone axe have been recognized in East Africa. Most of the specimens found were pecked and not ground into shape before being finally polished. No geographical significance can be attached to any of the five types; their distribution will probably be found to be very wide, though for the moment for obvious reasons they have mostly turned up where European settlement involving farming has taken place. A description of the various types, together with a list of some of the localities where they have been found, has been made available in a collection of reprints recently received*. A general sketch map, too, is appended. Finally, a short note on the occurrence of the different types outside East Africa concludes the article.

Gorgora, on Lake Tana, was a former Italian military station. The rock-shelter is situated some 150 ft. up in the side of a conical hill of volcanic rock which rises abruptly from the plain some three miles from the Lake. The shelter is most inaccessible and can only be approached from one direction. It is some 15 ft. long by 8 ft. at the widest. Black soil rich in humus was found from the surface to a depth

* "Notes on the Ground and Polished Stone Axes of East Africa", by Mary D. Leakey; "Excavations of a Rock-Shelter at Gorgora, Lake Tana, Ethiopia", by Colonel F. Moysey; "The Industries of the Gorgora Rock-Shelter, Lake Tana", by L. S. B. Leakey. Reprints of the *Journal of the East Africa and Uganda Natural History Society*, 17, Nos. 3 and 4 (77 and 78), 182–203.

of 4 ft.; then to the 9-ft. level there was a grey volcanic ash. At this level, concretions appeared, and these formations increased down to the 12-ft. level. Implements occurred throughout the deposits, and pottery was found to a depth of 3 ft. from the surface. There were no sterile layers.

Dr. Leakey's analysis shows that the industries of the 12-, 11- and 10-ft. levels can be classified as Early Stillbay; those from the 9-, 8- and 7-ft. levels as Middle Stillbay; those from the 6-, 5- and 4-ft. levels as Upper Stillbay; those from the 3-ft. level as Magosian; those from the top 2 ft. of deposit as late Mesolithic or Neolithic. This industry includes some crude microliths, and appears to be derived from the earlier Magosian. A few simply decorated sherds were also discovered in this level. The industries from the older levels are fairly typical, but the 4-ft. level gives us a transition stage between the latest Stillbay and the Magosian. An analysis of the different types of artefact found is given, and the article is well illustrated.

The rock-shelter at Gorgora is obviously of some importance. Such transition industries as those of the top 2 ft. and the 4-ft. level are very interesting. The excavations are not yet completely concluded, and it is to be hoped that further investigations at this site and elsewhere in the neighbourhood will be undertaken at a not too distant date.

M. C. BURKITT.

## QUARTZ CRYSTAL MODEL

DIFFERENT types of deformation extend the range of frequencies that quartz plates can cover and a single plate may be used for totally different ranges when made to vibrate in different modes. To obtain most of these various modes of vibration the plates must be cut from the mother quartz at different angles with respect to the electrical, mechanical and optical axes of the quartz crystal. There are also special orientations which provide better frequency stability in cases of temperature changes, and these orientations are used where stringent temperature requirements apply.

A recent interesting article by F. Caroselli (*Bell Lab. Rec.*, **22**, No. 9; May 1944) describes and illustrates a large fabricated model of a quartz crystal, employed for showing more clearly the angular relations of the various cuts of plates to the original mother crystal. The model has an outer shell about two feet high that shows the typical shape of quartz as it grows in Nature, and an inner display of crystal plates. The shell and display tiers are made of sheet lucite and the plates are lucite, roughened to appear like etched quartz. The plates include those used for oscillators and filters.

About the vertical axis the outer shell shows an array of faces that repeat three times in exact symmetry. This is the optical axis, and it is the only direction through quartz along which a light ray will travel without dividing into two rays of different velocities which are refracted by different amounts. The shell can be rotated with respect to the inner display so that its faces can assume three identical orientations with respect to the crystal plates. Three pairs of $X$ and $Y$ axes are marked on the apron of the model to demonstrate the trigonal symmetry of quartz.

Before constructing the outer shell of the model, formulæ were developed from published crystallographic data to compute the angles between adjacent faces. All identical faces were made the same size by having the major apex faces meet in the vertical axis of the model. Minor apex faces were located at an arbitrary distance from this central axis.

The model illustrates cuts used in ranges varying from less than 1 kc. to 24,000 kc., and each one is particularly suited for a definite range of frequency. In addition, there are several different cuts operating over the same range but having some specific characteristic. On the top tier of the display there is a plate the coating of which is divided so that it will vibrate by flexing the major surfaces; and on the bottom tier are a number of plates of the same cut but with the coating divided to excite the third, the fifth or seventh harmonics of a longitudinal mode of vibration.

## COLOUR TELEVISION

A DEMONSTRATION was given a short time ago by Mr. J. L. Baird of his recent achievements of the reception of television in colour by a method which avoids the need for revolving disks and lenses; the apparatus is thus silent in operation and is claimed to be as efficient as the pre-war black-and-white receivers. The pictures in colour are also utilized to produce stereoscopic effects by the use of coloured viewing glasses, the left and right eye pictures corresponding to the left and right eye images.

For the reproduction of the received pictures a special cathode ray tube, termed a 'Telechrome', is used; this differs from the ordinary tube in having two cathode ray beams and a transparent double-sided screen. These two cathode ray beams are modulated by the incoming signals corresponding to the two primary colour pictures; and they impinge obliquely on opposite sides of the screen, these sides being coated with fluorescent powders of the appropriate colours. Thus the screen has formed upon its front face an image containing the orange-red colour components, and on its back face an image containing the blue-green components. When the screen is viewed normally from the front, these images are superimposed and thus give a picture in natural colour.

Such a two-sided tube has been developed with a screen, 10 in. in diameter, and was shown receiving a picture from a 600-line triple interlaced moving spot transmitter using a cathode ray tube in combination with a revolving disk with orange-red and blue-green filters. The tube gives a very bright picture due to the absence of colour filters and the fact that special powders are used giving only the desired colours, which are seen additively.

A method of using three colours has also been described in a patent specification. In this case, the back of the screen is ridged: the two sets of faces of the ridges are coated with blue and green powders respectively; and they are scanned by two cathode ray beams, modulated by the blue and green components respectively, of the incoming signals. The third beam, carrying the red picture components, impinges on the front of the screen as before. A new form of scanning is also being explored, using successive lines of different colour, with the object of reducing the colour flicker which is obtained when, as at present, the colour changes are by frame to frame only.

# FORTHCOMING EVENTS

### Saturday, September 23

BRITISH PSYCHOLOGICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 2.30 p.m.—Prof. J. C. Flugel: "Psychological Aspects of Moral and Social Progress" (Papers in comment by Dr. Karl Mannheim and Dr. R. H. Thouless).

### Tuesday, September 26

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Dr. S. C. Bradford: "Some General Principles of Bibliographical Classification, with application to the Universal Decimal Classification"; Mr. C. L. Gilbert and Mr. C. G. Gray: "The Classification of Literature in the Technical Department of an Oil Company".

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Princes Gate, South Kensington, London, S.W.7), at 6 p.m.—Mr. T. Thorne Baker: "Some Uses of Dried Emulsions in Photographic Industries", with a Demonstration of Silk Screen Printing.

### Wednesday, September 27

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 2.30 p.m.—Mr. L. C. Southcott and Mr. D. W. Rudorff: "Superheaters for Water Tube Boilers".

### Friday, September 29

BIOCHEMICAL SOCIETY (in the Department of Biochemistry, The University, Western Bank, Sheffield), at 11 a.m.—The 236th Meeting.

ROYAL INSTITUTE OF CHEMISTRY (joint meeting of the BIRMINGHAM AND MIDLANDS SECTION with the INSTITUTE OF PHYSICS) (in the Connaught Room, Imperial Hotel, Birmingham), at 6.30 p.m.—Dr. G. W. Scott-Blair: "Rheology of Plastics; Stress-strain-time Relations for High Polymers and Similar Materials".

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DEPUTY CHIEF ENGINEER—The Borough Electrical Engineer and Manager, Guildhall, Swansea (September 28).

LECTURER (full-time) IN PHYSICS—The Principal, Royal Technical College, Salford (September 29).

CHEMIST to the Tees Valley Water Board—The Engineer and General Manager, Water Board Offices, Corporation Road, Middlesbrough (endorsed 'Chemist') (September 29).

SPEECH THERAPIST—The Director of Education, Shire Hall, Nottingham (September 30).

GRADUATE ASSISTANT MASTER IN ENGINEERING—The Principal, South Dorset Technical College, Newstead Road, Weymouth (September 30).

SPEECH THERAPIST—The Director of Education, Stanley Buildings, Caunce Street, Blackpool (September 30).

CHAIR OF PHYSIOLOGY in the University of Ceylon—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (September 30).

CHAIR OF ELECTRICAL ENGINEERING—The Acting Registrar, The University, Leeds 2 (September 30).

CHAIR OF BIOLOGY in Victoria University College, Wellington, New Zealand—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (September 30).

PRINCIPAL OF THE HACKNEY TECHNICAL INSTITUTE, and PRINCIPAL OF THE SOUTH-EAST LONDON TECHNICAL INSTITUTE—The Education Officer (T.1), County Hall, Westminster Bridge, London, S.E.1 (September 30).

PRINCIPAL OF THE WALKER TECHNICAL COLLEGE, Oakengates—The Secretary for Education, County Buildings, Shrewsbury, Shropshire (September 30).

TECHNICAL ASSISTANT FOR LABORATORY attached to Engineering Firm (N.W. London district)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2278.XA) (October 2).

PHYSICIST OR ENGINEER, B.Sc. Grade, for scientific instrument development work (Oxford area)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. A.584.XA) (October 2).

ENGINEER AND GENERAL MANAGER to the New Zealand Hutt Valley Electric Power Board—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.931.A) (October 7).

EXAMINING OFFICERS (temporary) IN THE PATENTS OFFICE (candidates should have a University Degree (or equivalent) in Science or Technology with Chemistry as a subject)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2982.A) (October 9).

PROFESSOR OF PHYSICS—The Registrar, University College, Singleton Park, Swansea (October 18).

HONOURS GRADUATE IN CHEMISTRY (London, Reference No. F.2719.XA), HONOURS GRADUATES (2) IN METALLURGY (Neath, Reference No. F.2720.XA; Shipley, Reference No. F.2721.XA), and HONOURS GRADUATE IN CHEMISTRY or Member of the Royal Institute of Chemistry, Branch E (London, Reference No. F.2722.XA), on the research staff of a progressive National Organization with home and overseas interests—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting the appropriate Reference No.) (October 21).

QUALIFIED CHEMIST with some research and industrial experience, by a progressive concern in the Spen Valley district of Yorkshire—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.1737.XA) (October 27).

LIBRARIAN—The Librarian, Queen's University, Belfast (October 31).

CHAIR OF PSYCHOLOGY in the University of Sydney—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (October 31).

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ASSISTANT LECTURER IN AGRICULTURAL ZOOLOGY—The Principal, Harper Adams Agricultural College, Newport, Shropshire.

SECOND VETERINARY OFFICER, Imperial Bureau of Animal Health, Weybridge—The Secretary, Imperial Agricultural Bureaux, 2 Queen Anne's Gate Buildings, London, S.W.1.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

Scottish Society for Research in Plant-Breeding. Report (abridged) by the Directors and Report by the Director of Research to the Annual General Meeting, 20th July 1944. Pp. 34. (Edinburgh: Scottish Society for Research in Plant-Breeding.) [49

Tory Reform Committee. Bulletin No. 4: Government Policy for the Rebuilding of Urban Areas. Pp. 20. (London: Tory Reform Committee.) [49

Medical Research Council: Industrial Health Research Board. Report No. 85: The Recording of Sickness Absence in Industry. (A Preliminary Report.) By a Sub-Committee of the Industrial Health Research Board. Pp. 18. (London: H.M. Stationery Office.) 4*d*. net. [59

Transactions of the Royal Society of Edinburgh. Vol. 61, Part 1, No. 7: Cytological and Genetical Studies in the Genus Solanum, 2, Wild and Native Cultivated 'Diploid' Potatoes. By Dr. H. C. Choudhuri. Pp. 199–219+1 plate. (Edinburgh and London: Oliver and Boyd.) 5*s*. 9*d*. [79

British Standard Conversion Factors and Tables. (B.S. 350: 1944.) Pp. 96. (London: British Standards Institution.) 3*s*. 6*d*. net. [128

### Other Countries

Trinidad and Tobago: Forest Department. Administration Report of the Conservator of Forests for the Year 1943. (Council Paper No. 26 of 1944.) Pp. 6. (Trinidad: Government Printer.) 6 cents. [88

Bulletin of the American Museum of Natural History. Vol. 83, Art. 1: The Haplolepidae, a New Family of Late Carboniferous Bony Fishes; a Study in Taxonomy and Evolution. By T. Stanley Westoll. Pp. 122+10 plates. Vol. 83, Art. 2: The Birds of Timor and Sumba. By Ernst Mayr. Pp. 123–194. (New York: American Museum of Natural History.) [88

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 25, No. 9: The Perennial Southwestern Datura and the Validity of Matthew's Hypothesis in Plant Geography. By Joseph Ewan. Pp. 235–244. (San Francisco, Calif.: California Academy of Sciences.) [8

Imperial College of Tropical Agriculture. Eleventh Report on Cacao Research, 1941–43. Pp. 38+12 plates. (Port-of-Spain: Government Printer.) 5*s*. [88

### Catalogue

A Catalogue of Important Books on Natural History (Zoology and Botany). (No. 622.) Pp. 64. (London: Bernard Quaritch, Ltd.) 6*d*.

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CONTENTS



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# SCIENTIFIC AND INDUSTRIAL RESEARCH.—VI

WE have now completed our survey of the strategy and tactics of research in respect of the workers and organization required, and the broad objectives of programmes to serve the advance of science and the needs of the nation. We have now to view in conclusion, more from outside, the structure thus adumbrated; and to consider, not primarily the service to be rendered thus to the community, but the price that must be exacted from the community in order that such an organization may function effectively and render the services set forth. That support has two main aspects: financial and educational. Research in any field cannot be prosecuted effectively unless support is forthcoming on an adequate scale. Such support in turn is unlikely to be forthcoming unless the reasons for prosecuting research are adequately understood by the public; and once again, the case for research is unlikely to be presented effectively unless the possibilities are fully appreciated by the administrator, whether he be in Government service or in industry.

For our present purpose it is unnecessary to enlarge on the financial aspect. Estimates as to the cost of the programmes and of the organization involved are as yet incomplete or tentative. Many of the essential facts have yet to be determined, and even the programmes themselves to be outlined adequately. Sir Ernest Simon has estimated that the necessary expansion and development of the universities involves increasing the Exchequer grant to £4 millions in the first year after the War and successively to £8 millions in the fifth year, with capital grants on the scale of £20 millions over a period of ten years. The Parliamentary and Scientific Committee likewise visualizes an increase of the Treasury grant to six or seven million pounds, with at least £10 millions over the first five post-war years for capital expenditure, and the British Association Committee on Post-War University Education estimates this capital expenditure at £25 millions. The Association of Scientific Workers puts the total university expenditure at about £15 millions after five years and at £20 millions after ten years, most of which will have to come from the State; accordingly, it anticipates an increase in the annual Government grant to £9 millions after five and to £13½ millions after ten years.

This is only a part of the national research budget directly charged on the State, though, of course, a large part of the university expenditure is only indirectly for research purposes. Estimates as to the increased expenditure involved in the research directly financed by the State are fewer, and in any event are at present largely tentative in the absence of the essential surveys or broad programmes. The Parliamentary and Scientific Committee puts the desirable expenditure on coal research alone at "several millions" and on agricultural research at at least three millions per annum. In its statement "A Post-War Policy for Science", the Association of Scientific Workers puts

the cost to the State of the proposed increases at about £18 millions, of which £7 millions would be for industrial research (as against £3 millions pre-war), £6 millions for agricultural advisory services, six hundred thousand for agricultural research, £4 millions for medical research (in place of £2 millions before the War) and half a million for consumer research. Even this estimate takes no account of Colonial research, for which expenditure up to half a million a year has already been provided under the Colonial Development and Welfare Act of 1940, or of the social and economic research adumbrated in the Nuffield College statement and elsewhere.

It is sufficient, however, for the present purpose to note that expenditure ranging up to what might well approach £50 millions can scarcely be appropriated without widespread public understanding of its purposes and implications. It is most important that these calculations should be properly and exhaustively made and that the cost of expansion should be determined and apportioned. But it is even more important, as *The Economist* has pointed out, that in this process the right relation should be devised between the universities and public bodies, including local authorities as well as the central government. That can scarcely be secured unless on one hand the underlying issues are clearly understood by the local authorities, in Parliament and by the electorate, so that decisions are taken free from prejudice or the pressure of private or sectional interests; and on the other, the question of university research and finance is seen as part of, and in relation to, the wider question of the national research effort.

From this point of view, accordingly, it is all-important that in the comprehensive reconstruction of our education system, of which the Education Act embodies the first instalment, the system should be regarded as a whole, from the nursery school to the universities and adult education beyond the university stage. No matter how perfectly our research organization is designed to serve our strategy, embodies the correct tactics and executes the programmes planned, it will only be fully effective when it has the intelligent support of the body of the nation it serves. By this means alone can we be sure, as the history of the last twenty years shows, that no false economy or sudden demand for retrenchment will cripple the long-range plans which would bring immeasurable returns to the nation's balance sheet.

That point of view is clearly recognized by the Government. In admitting the Government's responsibility for giving a lead in this matter of research, the Lord President of the Council, Mr. Attlee, stated in the House of Commons debate that Government support for research must be backed not only by a readiness to use the results of that research, but also by public opinion and by the nation becoming more aware of the importance of science. Mr. Attlee regards the Education Act as an essential means of getting the nation scientifically minded, and stressed that there are three parties: the Government, industry and the general public. Our research effort will not endure unless, as Mr. Attlee said, public opinion is behind it.

No body is doing more in this work of public education than the Parliamentary and Scientific Committee, and Mr. Attlee paid fitting tribute to that work. Such educational work must be carried on outside as well as inside Parliament, and all scientific workers have their own opportunities as well as responsibility for sharing in the task. The Colonial Research Committee, in its first annual report, makes a sound point in emphasizing the importance of actively associating the Colonial peoples, through their Governments, with the planning and guidance of research. This point has an even wider bearing, for it may well be that until we can secure, in Great Britain as well as in the Colonial territories, that the ordinary citizen is associated with the planning of research, at least to the extent of gaining some understanding of its bearing on his everyday life and welfare, we cannot expect the sustained support and endowment of research on the scale now needed.

That task of education cannot be carried out without the wholehearted support and co-operation of scientific workers themselves, on whose shoulders much of the work of exposition and interpretation must necessarily fall. This is particularly true in respect of the special task of educating the administrator as to the potentialities of scientific research. We may indeed hope that further attention to the training of the administrator and manager, as part of our programme of educational reform, will explode the superstition that business and administration cannot be taught in a university, and demonstrate that a university can provide those whose profession is to be industry or business with a three-years discipline in the fundamentals of the problems they will meet in their professional career. Thus we may ultimately provide both industry and Government departments alike with administrators having sufficient scientific background to appreciate the scientific factors in the problems confronting them, and to discharge more adequately and imaginatively such functions as decisions upon research needs and priorities—a long-range task. The immediate problem is that of educating the present generation of administrators, who carry the responsibilities for the decisions that will permit or warp the post-war expansion of research. As Dr. D. R. Pye suggested recently to the London Institute of World Affairs, the primary responsibility of the universities to industry is to supply the qualified men and women, able executives with trained minds and initiative, capable of seizing upon and developing a new idea or a promising new process.

The concern with which the medical profession has viewed the Government proposals for a State medical service is at bottom due to distrust of the administrator. The weaknesses of the Civil servant as summarized in the recent report on "The Training of Civil Servants" . . . "over-devotion to precedent; remoteness from the rest of the community, inaccessibility and faulty handling of the general public; lack of initiative and imagination; ineffective organ-

ization and misuse of manpower; procrastination and unwillingness to take responsibility or to give decisions" . . . may be exaggerated, but undoubtedly exist, and Prof. H. J. Laski is right when he says that the control of research is often in the hands of men with no serious acquaintance with the possibilities of either natural or social sciences. If this situation is to be rectified, the tendency to departmentalism checked, means found for securing that Government departments are aware of the relevance of achievements of scientific men in other countries, and a more youthful outlook and representation achieved in the direction of the relations between the Government and science, scientific workers must translate their concern for professional and intellectual freedom into a sense of social responsibility which issues in both individual and in corporate action.

Dr. D. W. Hill, in his recent book "The Impact and Value of Science", has put his finger on the weak spot: "Until they have learned to express themselves, scientists will continue to be wallflowers at the world's quickstep". The faults are not all on one side. The indifference and even scorn with which scientific workers have treated this task of exposition is every bit as serious as the defects of the administrator already mentioned. As Dr. Hill says, scientific men must learn to write and to speak so that people will listen to them, and will understand and appreciate their efforts. In place of the isolationist and sometimes arrogant attitude to the administrator, scientific workers must adopt a sympathetic and co-operative attitude: they must seek to help, not to dictate. The task of intelligence calls for tact and sympathy and for imagination on both sides. The man of science as well as the administrator needs to be sensitive to opinion.

These factors are as important in the running of our research organization and in the functioning of its information services as lubrication in running a machine, and especially so in dealing with the present situation, when we cannot wait for a reformed educational system to provide us with improved types of experienced administrators. There is, however, another aspect in which educational reform is important to our plans for the expansion of research. The Association of Scientific Workers has pointed to the need for increasing the supply of laboratory technicians in order that we may make full use of even the existing numbers of trained scientific workers. Equally important is the supply of technicians in industry, and no plans for the expansion of applied research which take no account of the facilities for technical education can be expected to fructify.

The dependence of Great Britain's post-war plans on the provision made for technical education has been repeatedly emphasized of late. It is recognized, as the Nuffield College paper points out, that the management of a firm should include men with a sound knowledge of basic scientific principles and methods. The Government and the public should be similarly equipped. Thus, in the long run, the general need is for a spread through the educational system of a sound knowledge of basic scientific principles and method. Sir George Schuster urged in the House of Commons the need for a very great increase in the number of scientifically trained workers and for a very rapid development of all forms of scientific and technical education; and the Government educational programme was strongly criticized from this point of view in the House of Lords. The report of the London Chamber of Commerce on Scientific Industrial Research also recognized the importance of this question of technical education and urged the allocation of a far larger sum for the development of technical colleges than the £100,000 envisaged in the White Paper on Educational Reconstruction. Similarly, the report of the Parliamentary and Scientific Committee directs attention to the need for a great expansion in technical education, for reconsidering the position of the technical institutions with reference to the universities, and to the value of the large number of technical personnel now in the Forces, if suitably trained, on demobilization.

There is a further point stressed in this same report, as well as in that of the London Chamber of Commerce, which has frequently been overlooked. It is essential to find some means of restoring the status of the craftsman or artisan and technician, both in the laboratory and in the works. When all has been said about the necessity for further provision for technical training of the skilled workers and craftsmen which industry will require in growing numbers, to remedy the present inadequate provision for this purpose will not by itself be enough. There is an important body of industrial opinion which holds that the provision of technical education in Great Britain is inadequate and defective primarily because the country undervalues the man who works with his hands, and regards him as socially inferior to the office or professional worker.

To remedy a perverted social attitude is a matter that lies outside the field of education, in the limited sense of that term, and while the scientific worker will urge the importance of adequate provision for the technical training of the craftsman as bearing vitally on industrial efficiency and the effectiveness of our research organization, he cannot fail to note that here again he must accept some responsibility for attempting to reverse that attitude. More might undoubtedly be done by the example of professional associations, and the scientific worker is prone to overlook the influence that his own personal conduct and attitude may have on his fellow citizens and workers. Social attitudes may be reversed less by propaganda than by the quiet pervasive influence of conduct determined by principles firmly held and resolutely but sympathetically and sincerely explained.

It is not only the general public and the administrator who in such ways as these must be educated to understand the needs and possibilities of the situation in order to enable our research organization to function effectively. Reports from the Department of Scientific and Industrial Research have repeatedly stressed the need for more publicity in industry, and for the education of industry, in order to make the work of the research associations, for example, effective. It has become an important function of some research associations to secure the translation of their

results into terms which are easily assimilable by the industry. The task of public relations has acquired a special significance in this respect for securing that industry is research-minded, and both the report of the London Chamber of Commerce and that of the Industrial Research Committee of the Federation of British Industries have directed attention to this point.

The London Chamber of Commerce urges that chambers of commerce, trade associations and industrial federations should give attention to this question of publicity generally, providing information and advice as to the steps to be taken by firms to get specific research done for them and to utilize the research facilities available. It also suggests that the B.B.C., the Press and the cinema should be used to stimulate interest in scientific work and to interpret the results of that work when applied to industry. That was to be one of the functions of the co-ordinating secretariat for industrial research suggested by Dr. P. Dunsheath, and it is one of the main functions of the bureau of industrial research suggested by the Federation of British Industries. This bureau, though supported financially by research associations, independent research laboratories, Government research establishments, universities and others, would be entirely objective in its activities. Among its suggested activities are the publication of a year-book, in which could be included a short description of the achievements of British research and of the facilities available for the prosecution of research, and educational publicity on research.

In addition to advisory functions on research problems, the Federation of British Industries' Committee visualizes such a bureau as possibly creating a liaison between research workers in similar or related fields. Its existence would in the opinion of the Committee increase the research-mindedness of British industry and foster a greater national sense of the importance of the subject and its influence in maintaining national prosperity and well-being. It might indeed assist in imparting to those responsible for management in large or small firms a scientific approach and understanding of their problems, and encourage a readiness to give a high place in business affairs to the claims of scientific research ; though it can never absolve us from the responsibility already indicated of thinking in terms not only of supplying industry with adequate staffs of experienced research workers but also with managements capable of co-operating fruitfully with them.

The importance of establishing some new machinery for such purposes and of providing adequately for the organization of information or intelligence services is clear, but it must not be forgotten that organization by itself is not enough. We have already outlined the kind of organization which may be required to serve the broad strategy of research and to execute the programmes which may be planned to serve the national needs. We have stressed the need for keeping that organization flexible and sensitive, for development in accordance with the experience of the past, for avoiding compartmentalism or departmentalism; and that in our planning the first attention must be given to the supply of the right personnel.

In this matter of securing adequate and sustained support of research and the effective utilization of its results, the question of personnel again comes before organization, but with a different emphasis. Success in such publicity and educational work depends largely on those who carry it on, and here the scientific worker must always have a large, and at the start a major, responsibility. Educational reform is a slow process, and the full effects are only felt after a period of years. The immediate task of educating the general public, the administrator and industry as to what is involved must be done largely by them or not at all ; and if it is not done, our plans for the expansion and development of research are unlikely to go forward.

Scientific workers will not knowingly neglect their responsibilities, great or small, in such matters as the strategy, the planning or the execution of research. There are signs of an increasing concern with questions of tactics and that the professional associations may take wider and more public-spirited views on some of the problems calling for corporate action, to which in the past they have been indifferent. But the majority of scientific workers have scarcely realized the crucial importance of this task of interpretation and exposition involved in the education of the public, which must proceed step by step as our plans for scientific research are developed.

Research organization may be perfectly designed to serve the purposes of our strategy ; research programmes may be comprehensive and well co-ordinated ; but no excellence of administration or tactics can eliminate the dependence of success or failure on the human element. The research worker, too, does not work in a vacuum. He has relations with the Government or administration, with fellow scientific men in other branches of knowledge, with his fellow citizens in industry and elsewhere. Organization can only provide the means for co-operation, but without the determination or desire to co-operate and some sympathetic understanding of other points of view, organization will not function.

The adequate organization and planning of research involves a great partnership in which the scientific man, whether he be research worker or administrator or expositor, must take his place with those engaged in Departments of State, in industry and in a real sense the general public. The special responsibilities which fall on men of science in formulating strategy or planning programmes, in criticizing constructively the strategy, tactics or organization of research, as well as for the actual prosecution of research, must not lead them to overlook this further responsibility. The prosecution and organization of research can in fact only yield their full results when this task of interpretation and exposition—of educating public opinion as to what is required—is discharged with vision, imagination and persistent resolution, and in a spirit of public service which matches the devotion which scientific workers instinctively bring to the quest for truth in the laboratory.

## A NEW ENGLAND NATURALIST

### A Naturalist at Large

By Thomas Barbour. Pp. xii+314. (Boston, Mass.: Little, Brown and Company, 1943.) n.p.

IN the lives of the older naturalists, as of Louis Agassiz when he was young or John Hunter when he grew old, we find examples of quite peculiar happiness. All their labour was for the love of it; they did exactly as they pleased; they shared a carefree corner of the world with the painter and the poet. Dr. Thomas Barbour is one of the last of the old-fashioned naturalists, and it is the same way with him. He confesses, or boasts perhaps, that "he never does anything he don't want to do—not if he can help it"; and in consequence a glow of happiness runs all through his random reminiscences.

Dr. Barbour has been a museum man all his days, first in Boston, then in Salem, and lastly in the great Agassiz Museum in Cambridge, Mass., which he has had charge of for many years. He has the golden gift of friendship. He has known all the naturalists of his time; he has travelled far and wide, and his fellow-naturalists all the world over have a friend in him. He is a famous museum curator. He has added immense collections to the great museum founded by the elder Agassiz and enriched by his son; he knows what to store away and what to exhibit, and how to label a nightingale or an albatross for the instruction and benefit of ordinary unpedantic mankind.

Rumphius and Wallace set him travelling (with his young bride) to the Dutch East Indies, as they have led so many another naturalist on his way. There, in Ternate, he shot the Rajah's own cockatoo (and had "the devil to pay"); and found a wonderful lizard "with a great fanlike sail on its back and tail, like a Permian Pelycosaur in miniature", which Wallace and Max Weber had both failed to discover. He has explored Central America and Mexico, made countless journeys to the West Indies, visited South Africa later on, and brought stories as well as rich collections from them all. He has a fresh boyish enthusiasm for every rare and beautiful creature. A certain mouse from Darien, golden-brown above and pearly white below, is "a veritable gem among mice"; a tiny frog from Trinidad, living up-country in Bromelia flowers, is "a lovely little creature, tiny, but with eyes like jewels"; and a crystal-clear pool in a Cuban cavern holds "fairy shrimps of a most heavenly crimson, with white tips to their appendages as if they had stepped about delicately in white ink". They had been lost and forgotten, since they were seen long before by Felipe Poey, the first great Cuban naturalist. Dr. Barbour is a botanist among many other things, and for many years he has been in charge of the garden at Soledad, in Cuba, which belongs to Harvard University, and is now one of the great tropical gardens of the world. One of the inhabitants of this famous garden is "an indescribably lovely little frog, scarce a quarter of an inch long from stem to stern"; it had been described by Cope, and lost sight of for some sixty years. At Maracay, near Caracas, he saw the wonderful zoo which the old dictator Juan Vicente Gomez had formed, with the help of one of the Hagenbecks. Here enormous hippos lived in a pretty lake—around which giraffes, zebras and a host of antelopes wandered as if they were at home; and here were many greater rarities, such as spectacled bears from the Andes, the only bear in South America, and a whole colony of Pacaranas, or Dinomys, one of the largest of all the rodents, very curious and exceedingly rare, unknown to our own Zoo and to the British Museum.

Dr. Barbour is not less interesting when he talks freely of his fellow-men. He has some new stories to tell of Cope and Marsh, the two great palæontologists, bitter rivals and cunning foes; of David Fairchild, who married Alexander Graham Bell's daughter, and became a world-famous gardener and agriculturist; of Samuel Garman and H. F. Osborn and Leonard Stejneger; of E. S. Morse and of the much-loved "Uncle Bill Wheeler", who only died the other day; of President Lowell, and of Oliver Wendell Holmes (the judge not the professor) "who was one of the greatest men I ever knew—perhaps the greatest", but with one blind spot, common enough in frail humanity.

There is a modest paragraph about the luncheons in Dr. Barbour's own den in the Agassiz Museum—he calls it the "Eateria"—which Henry Bigelow and he set agoing years ago, and to which countless scientific men from all the world over have been hospitably bidden and been glad and proud to come. The cuisine is justly celebrated, even since "old Gilbert" died; and there are said to be tanks in the basement where turtle and terrapin await the illustrious guest.

This is a very human book, by a very lovable man. There is a certain oddity about it, and about him—which comes of working in a museum, and loving it, all his life long. For to be a true museum man, as Tom Barbour (or his daughter) says, "You don't *have* to be crazy, but it certainly helps".

D'ARCY W. THOMPSON.

## PSYCHOLOGY FOR MEDICAL STUDENTS

### Sane Psychology: a Biological Introduction to Psychology

By Prof. R. J. S. McDowall. A revised and enlarged edition of "A Biological Introduction to Psychology". Pp. xii+275. (London: John Murray, 1943.) 9*s*. net.

THE urgent necessity that the medical student should know as much as possible about the workings of the normal as well as the abnormal mind needs no underlining, though it has recently been emphasized by the General Medical Council. The present book, "for students of medicine, theology and education", is a brave attempt to meet these needs.

It seems fair to set down some requirements of a modern text-book of general psychology. (1) It should be simply written. (2) It should give numerous everyday examples of normal experience and behaviour, including that of children. (3) Abnormal psychology should not be regarded as determining the lines of normal psychology. (4) The concept of mental normality should be fully discussed, with especial reference to the relation of personality to culture-pattern; a normal commando-member who behaves like one, a week after the War ceases, will provide a headache for the ex-army psychiatrist also recently demobilized. (5) The theoretical and practical value to psychology of physiological knowledge should be realistically indicated; study in minute

detail of tiny bits of the lower animals is not always the best guide to a medical man trying to understand an intelligent delinquent or a hysterical amnesic. (6) It should appreciate the very extensive recent study of the individual personality, of idiographic as well as of nomothetic psychology. (7) The zoolatrous leanings of the early twentieth-century psychologists should be re-interpreted in the light of recent work by Americans. (8) And, arising out of (7), there should be recognition—especially desirable in a book written for 'medicals'—of the part played by culture in human life; by art, music, humour, philosophy, religion.

I suggest that Prof. McDowall be given good marks for (1), (2), (3), (5), and be referred for further study concerning (4), (6) and (8).

The medical student will welcome this book, with its convenient sub-headings, good index and bibliography. It will help him to answer examination questions, and provide excellent clinical examples when he is justifying psychological medicine to excessively extraverted athletes, or perhaps to his medically qualified father and grandfather. But another book, or lectures, will be needed to remind him of many happenings in the world of psychology during the last thirty years. One is the dropping of the word 'lunatic' and 'asylum' by the general public (writers on mental disease are catching up).

But many young students nowadays read psychology as part of their general education. They will rub their eyes at certain chapters in the present book and ask: Do nations think? Have nations instincts? What are the facts behind the assertion "the desire to learn may be largely hereditary" (there must have been a lot of hereditary learners lately in the U.S.S.R.)? Why is there nothing about the transformation and functional autonomy of human motives? Does the author's frequently and honestly expressed attitude towards medical practice and medical students merely reflect his own culture-pattern, and what would the recently qualified medical practitioner think of it?

A competent lecturer, however, can fill in these gaps—until, as I hope, Prof. McDowall does it himself in yet another edition of this book. But may we hope for a different title? Prof. McDowall is certainly a sane psychologist. Is there, however, such a subject as 'insane psychology'? Until I see books entitled "Schizophrenic Physics" or "Homophobic Biology" I shall continue to think the present title perfectly terrible. T. H. PEAR.

## VARNISH-MAKING

### Varnish Constituents

By Dr. H. W. Chatfield. Pp. xvi+496+12 plates. (London: Leonard Hill, Ltd., 1944.). 35s.

THE title of this book immediately carries the mind to varnish-making, a subject with its own small and select but most engaging literature for anyone who is willing to venture a little. Dr. Chatfield's book takes its place, as it were, at the end of the row; but how different it is from some of its predecessors. Naturally his book has been produced to the authorized war economy standard, but even without that measure of austerity, the book would still carry the air of battle-dress—business-like and efficient, everything set out in order, plenty of detail arranged in tabular form, a contents page (nine pages, in fact) minutely analysed, and a substantial index.

All this, no doubt, is in the spirit of the times, but how different from another notable book on the same subject by Sabin, written (actually it was re-written) and published during the War of 1914–18 and entitled "The Industrial and Artistic Technology of Paint and Varnish". Both these books have their place indeed, the one for the office and laboratory, the other for the laboratory and the leisurely student after business hours. It is to be hoped that the modern touch will not deprive us of the interesting historical references, the little anecdote, including, for example, the story of how the craft of varnish-making was brought to England and particularly to the city of Ripon, about 1770. Even the firm with which Dr. Chatfield is now associated has been engaged in the craft since 1803. Surely some historical survey of the subject, however short, is necessary to a full appreciation of the craft as it is practised to-day, for in spite of its strong chemical, and particularly synthetic chemical, background, it is still in large measure an art practised by craftsmen.

Working backwards in time, the present War has crowned the synthetic chemical aspect of varnish technology which grew between the Wars and became the outstanding feature of the period. To-day, many operations associated with varnish-making are carried on in a way sufficiently large to provide problems in chemical engineering; there will be more of them as chemical processing develops. Indeed, it is most likely that linseed oil, hitherto the oily bulwark of the industry, will come to be regarded more and more as a material for chemical manipulation into products which will in turn be regarded as the true raw materials of the industry.

The suggestion that drying oils from petroleum will be available after the War (for in the United States they are even now being used to some extent) is no idle boast, and the picture presented by the advertisements in current American technical journals, fantastic as they may appear to the older generation, do forecast more than a modicum of the shape of things to come.

The post-1914 war developments in varnish-making technology and the form they took were determined first by the widespread appreciation of the valuable properties of tung oil arising out of war experience with products made therefrom; secondly, there was the amazingly rapid development of the nitrocellulose lacquer industry, which is an almost classic example of turning swords into ploughshares.

The stirrings of mind and method which have brought the industry to where it is to-day began about the turn of the century or perhaps a little earlier. This was the time of the scientific revolution when organic chemistry began to open up, and when, to quote a few items that casually come to mind, rosin was esterified, Baekeland began his work on phenolic condensation products, and a survey was made of the natural resin resources of different parts of the world. The impact of this developing scientific background made manufacturers begin to think; but it was a long time before it was obvious to many of them (and indeed to-day it is not yet obvious to all of them) that it was necessary to abandon, or at least modify in favour of the scientific approach, those well-established methods which had flourished and served the industry so well during the period from about 1840 until 1900, when England was the premie

varnish-making country of the world and the industry enjoyed great prosperity. The eighteenth century was the period of transition. Up to then varnish was mainly associated with artists, and its making was part of their scheme of work. After then the uses of varnish became more widespread and various, and varnish-making gradually became a specialized industry. So one could travel backwards through the materials of medieval painting almost to the beginning of civilization and find much of interest relating to varnishes of one kind or another.

There is no doubt that this book will be appreciated, for even if Dr. Chatfield has not concerned himself with historical matters, he has collected a mass of useful and very up-to-date information about materials and their processing, which the worker in this field will find extremely useful. More and more of the products of chemical industry, particularly that part of the chemical industry associated with plastics, are being proved suitable as raw materials for varnish, in such variety as to force increased specialization and to develop a serious divergence in thought among technologists as to what is happening to the industry and what its future course will be. At the moment the varnish industry is certainly a case of chemical indigestion—much too much has been and is still being put upon the plate. Probably most of the technologists and scientific men concerned are trying to form, or maybe have formed, a working hypothesis to guide their actions; but it is doubtful whether many of them are wholly satisfied with their mental picture. This book will help to clarify some of the issues and may perhaps result in better co-ordination between the views of leading technologists. It will—and this is more important—help individuals who have only sketched in the barest outline of their mental picture of varnish-making in the post-war period.

In the author's preface, he says that, having felt the need personally for collected information about the properties of available raw materials and their manner of use, he has attempted to review the more important developments of recent years and to fit them into a complete whole. Unquestionably he has done what he set out to do and has done it extremely well. The review method he has adopted, however, has weaknesses, because so many references to patents and to other reported experimental procedures are inevitably included which are of no particular value and are sometimes misleading. In general, the reader is left to form his own judgment as to the value of the record given, but what is wanted is a weighted appreciation of all the evidence presented; indeed, in those sections of the work with which the author is clearly more at home he has done this to some extent in spite of his disclaimer that: "I have presumed to dogmatise and criticise as little as possible but rather to present the intelligent reader with the evidence from which his own conclusions may be drawn". The reader will surely form his own conclusions when he can, but he cannot always do so, and in any event he will like to have the professional's, that is the author's, conclusions as well.

As to the actual contents of the book, it is implied in what has already been said that the subject has been treated as on a broad canvas, with many items, some treated in fair detail, others less so, according to importance and the inclination of the author. There are no sections or aspects of varnish-making and varnish-making materials to which some reference will not be found.

L. A. JORDAN.

# RADIO WAVES AND THE IONOSPHERE

**Radio Waves and the Ionosphere**

By T. W. Bennington. Pp. vi+81. (London: Iliffe and Sons, Ltd., 1944.) 6*s*. net.

A VAST number of people are nowadays interested in one or other of the aspects of radio communication, and they are necessarily concerned with the manner in which radio waves are propagated around the earth's surface and to distances beyond the horizon. These and older students of the subject have become aware of the fact that such propagation is possible as a result of the existence of the ionosphere—those regions of the earth's atmosphere which become electrically conducting by ionization chiefly under the influence of ultra-violet radiation from the sun. It does not, however, require much delving into the subject to discover that the ionosphere is not simply equivalent to a metallic electrically conducting sheet in the same position at all times and seasons. It is rather in the nature of a series of partially conducting layers, one above the other, each varying in height and conductivity with time, and the lower layers sometimes shielding the upper ones from radio waves transmitted upwards from the earth's surface. Whether or no such upgoing waves are deflected back to earth from the ionosphere depends upon solar conditions, time of day, season of year, position on the earth's surface, and upon the frequency of the radio waves and the angle at which they are projected upwards from the earth.

While there is an extensive scientific literature giving the results of original investigations into this somewhat complicated subject, it has not hitherto been easy for the 'man-in-the-street' and the general scientific student to gain a clear view of the salient points in this field. In his recently published little book, details of which are given above, Mr. T. W. Bennington has filled this gap in an admirable manner; and he appears to have achieved his desire to provide a very lucid account of this subject for the benefit particularly of those whose knowledge is confined to school physics and the elements of radio communication.

The scope of the book is well defined on the comprehensive contents page, which has rendered an index unnecessary. After drawing a distinction between ground and sky waves, descriptions are given of the main properties of the ionosphere and the radio methods by which these are explored. The variations in heights of the various regions and their critical frequencies as determined by the density of ionization are described in some detail with the aid of well-selected samples of data obtained in Great Britain and in America. Later chapters deal with the part played by the ionosphere in long-distance radio transmission, and with the influence of the above variations and of ionosphere disturbances and other abnormalities on the effectiveness of the resulting communication. In addition to being written in an interesting manner, the book is scientifically accurate; and altogether the following comment given by Sir Edward Appleton in his foreword is well deserved: "Although it is primarily written for the professional radio technician who wishes to understand more about his own subject, I recommend it as a friendly and well-informed guide to anyone interested in long-distance radio communication."

# POST-WAR UNIVERSITY EDUCATION

By PROF. FRANK HORTON, F.R.S.

THE report of the British Association Committee on Post-War University Education, published on August 1, had its origin in the conference on Science and World Order held under the auspices of the Association in September 1941. The Committee was constituted under the chairmanship of Dr. Maxwell Garnett with the following terms of reference:

1. To consider the general policy and methods of university education with a view to promoting international collaboration and the free interchange of ideas, and relating university education to the needs and service of the community.

2. To consider the replanning of teaching departments and curricula in accordance with modern conceptions of the interrelation of different branches of knowledge, particularly those of science and the humanities.

3. To survey the position regarding teaching material, apparatus, books and staff in universities which have been damaged, disorganized or closed as a result of war, and to make recommendations for their rehabilitation.

The Committee published interim reports in 1942 and 1943, in which it set forth its views together with recommendations on various aspects of items 1 and 2 of its terms of reference, in so far as these deal with university education in the United Kingdom, particular points with which these interim reports have dealt being university entrance scholarships, university finance in Great Britain, universities and the public service and universities and adult education. The subject-matter of all these reports together with the findings of the Committee on other matters within its terms of reference are incorporated in the final report which is now published*. This has a preface by Sir Richard Gregory, president of the Association, and is divided into three sections corresponding to the items of the Committee's terms of reference, but deals in the main with those developments of general policy and methods which the Committee considers desirable in both school and university education in Great Britain.

How can we sum up what should be regarded as the outstanding educational needs of the community at the university-level, the satisfaction of which should be aimed at in university policy? The answer given in the present report is: (1) to get into our universities a larger proportion of those who are going to be the leaders of their generation; (2) having achieved this end, to educate them in such a way as to enable them to cultivate a wider and more integrated outlook on life as a whole; (3) for universities to take a far bigger part than they have done in the past in the education of those who enter the public service, not only before entry, but also after some experience of the service has been gained, and in providing an opportunity of university education for officials of lower rank than have normally enjoyed this privilege; (4) for the university schools of education to play an essential part in the education of all qualified teachers; (5) an expansion in the provision for vocational and non-vocational adult education.

The consideration of how to achieve the first two of these aims has led the British Association Committee to much serious criticism of present scholarship examination systems and of both school and university education. The Committee shares the prevalent view that a much more extensive provision of State and local aid to finance a much greater number of students through a university career is essential in our future educational policy. The Committee appears to envisage the increase of the number of these awards to such an extent that, after meeting the needs of all the candidates of outstanding intellectual promise, there would still be a number of awards available for candidates of less ability whose claims to consideration would be based mainly on their possession of social and civic qualities. It would seem that some adequate system would have to be devised for assessing the other factors which contribute to what the Committee terms "university-worthiness". The best the Committee can suggest in this respect is, after making awards to the candidates of high intellectual promise, "to pick the others empirically on a general impression of their scholarship-worthiness and without attempting an order of merit". Here we seem to be up against an identification of university-worthiness with scholarship-worthiness, and a disregard of the fact that, even if the number of awards is greatly increased, it is unlikely that this number will be as large as the number of candidates, so that an order of merit must be decided.

These awards are all spoken of as "scholarships" by the Committee, but we feel very strongly that the term "scholarship" should be limited to an award which is given for high intellectual ability and should not be applied to an emolument awarded mainly for social and civic qualities. The designation "State bursary" which has been used during the War to describe the emoluments awarded by the Board of Education, sometimes to students of little outstanding ability, might perhaps be continued.

It is suggested in the report that to prevent boys and girls of high intellectual ability from having to do a round of scholarship examinations in the hope of obtaining sufficient funds to finance their university careers, winners of open scholarships or exhibitions at Oxford or Cambridge (or successful candidates for admission to the women's colleges at those Universities) should be treated as if they had won national scholarships. So far as open scholarships are concerned it is generally agreed that this would be a good plan, provided the number of such awards is maintained at about its present level and the monetary value of the scholarships is not diminished; but it is clear that such a scheme, if adopted, must apply also to open scholarships awarded at other universities and not be limited to Oxford and Cambridge. In regard to the suggestion that all successful candidates for admission to the women's colleges at Oxford and Cambridge should also be treated in this way, one feels that the Committee cannot have realized the consequences of such action. The annual admission to the women's colleges at Cambridge is about 150 and at Oxford about 250, and thus the scheme might involve a yearly total of approximately 400 national awards being ear-marked for women at Oxford and Cambridge out of a grand total of about 1,600 annual awards contemplated for men and women together in all the Universities of England and Wales.

The outstanding theme which underlies all the Committee's criticisms of present higher school certificate examinations, university scholarship examinations and university curricula is over

* British Association for the Advancement of Science. Report of Committee on Post-War University Education. Pp. 52. (London: British Association, 1944.) 2s. 6d.

specialization, which the Committee, in common with other bodies which have published opinions on the subject, sees as a menace permeating the whole system of education and resulting in failure to cultivate a wide outlook on life as a whole. The universities are blamed for forcing this over-specialization on the schools by their system of selecting entrance scholars and also by supplying the schools with too high a proportion of specialist teachers. In its effect on boys who are not of exceptional intellectual quality, the scholarship system, especially that part which operates through the higher school certificate examinations, is described as giving rise to a product which, at the end of a university course, is scarcely adequate to the daily experiences and social contacts of a routine job in life. This condemnation of the whole range of the educational system is very sweeping, and we cannot but feel that the members of the British Association Committee must have been singularly unfortunate in their contacts with the products of that system who owe their university careers to their performances in higher school certificate examinations. The universities are taxed also with having failed to develop character and leadership, and with handicapping the growth of these qualities in that fraction from the poorer homes which is admitted to the universities through scholarships, by giving them a "one-sided education of a pernicious kind". So far as we can gather from the report, the perniciousness of the education lies in its specialized character and the lack of what the Committee describes as an integrating principle. 'Pernicious' is a strong word, and we do not see that any case is made out in the report which justifies its use.

The remedy suggested by the Committee begins with a new sixth-form curriculum in schools. The authors of the report would like to see a sixth form programme comprising "four general courses covering, respectively, the humanities, the social sciences, the physical sciences, and the biological sciences, affording a connected and complete, if not very profound, view of the whole of civilisation and life". It is suggested that English expression, a modern language, and sometimes mathematics might also be included, and it is envisaged that half the time spent in class would be devoted to these or a similar range of subjects, and the remaining half to the study of one special subject which would also occupy as much of the pupil's private study as he chose to devote to it. In recommending the allocation of so much of the time spent in class to non-specialist studies, the report goes beyond the suggestions in the report of any other body we have seen, and it is doubtful whether a pupil would gain any real advantage from the general courses unless he were encouraged to spend a proportionate amount of his private time on the subjects they comprise.

Alongside this modification of the sixth-form curriculum, the Committee recommends an increased encouragement of extra-curricular activities, and emphasizes that the effectiveness of the proposed changes would depend upon there being a corresponding modification of all scholarship examinations. It expresses itself as being strongly in favour of following this up by the introduction in universities of a type of general degree course, including both natural science and the humanities, which it hopes many students would take in preference to the more specialist courses. The report gives in some detail an account of what is envisaged as comprising such a course in "Philosophy, Natural and Social". One wonders whether those primarily interested in the study of the humanities would be satisfied with the share allotted to their subjects in the programme outlined. As a course for those chiefly interested in science, there is much to be said in favour of a syllabus of this kind, though there seems to be an over-estimation of what a student is capable of doing properly in a given time in the insistence that candidates for honours, in addition to being examined in the subjects of the course, should have also to translate and comment upon passages from French and German authors, *including set books*. If the study of the sciences outlined, their history and social significance, is to be serious and not the acquirement of a mere smattering of information, there would surely be little time available for any study of set books in foreign languages which would have real educational value.

For those undergraduates who choose to follow specialist courses in natural science, the Committee advocates the introduction of some study of sociology and citizenship by means of "special interest courses", general courses, and discussion groups, all conducted by persons understanding, and in sympathy with, the background interests of the students. It is not clear whether it is the intention that these studies should play any part in the examination for the degree.

In the conviction that it is the duty of universities to ensure that every undergraduate acquires some appreciation of the world as known by science, the Committee has set out what it considers should be aimed at in a course which is described as "Science for All". The list of subjects which is included in this course is very comprehensive and might perhaps be difficult to deal with in practice, but a strong case is made out for providing some such course.

Under the headings "Education for the Public Service", "Universities and the Education of Teachers" and "Universities and Adult Education" the report covers ground which has been explored by other committees which have recently published reports. The discussion on "World-wide University Collaboration" and the section on "Rehabilitation" gain special interest and importance from the assistance of distinguished academic members of the Allied Nations in their compilation.

In the section of the report which deals with university finance in Great Britain, we are glad to see the British Association putting forward suggestions which the universities themselves have been advocating for a long time, namely, an all-round improvement in the salaries of university teachers, the provision of residential accommodation for students of the newer universities on a much more extensive scale, an increase in the number of teaching officers and technicians on university staffs, and a much more generous expenditure than hitherto on facilities for research work.

On the question of salaries of members of university staffs the report emphasizes the present inadequacy of these in comparison with those ruling in other professions, and states that in the lower ranges they are, in some universities, insufficient to afford a reasonable standard of life under prevailing social conditions. The opinion is expressed that all whole-time professors in all English universities should be in receipt of "at least £1,500 a year at 1938 prices", and that certain subjects such as engineering and medicine should command salaries up to £2,500 per

annum, it being assumed that some form of family allowance scheme will be in operation and applicable to all university personnel. The report, however, makes no suggestion that the salary attached to the headship of a department should, in general, depend upon the size of the department or on the amount of administrative work attached to the headship, nor does it point out that a higher salary scale for all grades of staff should prevail in London, where living expenses are greater than in the provinces—a fact usually recognized in the salaries of other professional persons.

According to the University Grants Committee's "Returns from Universities and University Colleges" for the years immediately preceding the present War, the expenditure on staff salaries formed about one half the total expenditure of universities, so that a general increase in salaries on the scale envisaged will require a large total increase in university incomes. The present total expenditure on staff salaries is about £3¾ millions per annum, and it appears that the increase needed immediately to bring salaries up to the desired level is not less than £1½ millions per annum, a sum which is about two thirds of the present annual parliamentary grant to universities and university colleges in Great Britain. The Association's report points out that, for the future, universities will inevitably have to look more and more to local and national grants for the needed increases in their resources, and it urges that the Treasury grant should at once be doubled after the War. The rough estimate made above shows that a doubled Treasury grant would need to be supplemented by considerably increased grants from local authorities if university education is to be made available to a greatly increased number of students, for this would involve an enlargement of existing staffs and increased maintenance charges for libraries, laboratories, and social amenities. In addition to increased recurrent grants for maintenance, most universities are urgently in need of large capital grants for the purchase of building sites and for the erection of additional accommodation for students' residences as well as for laboratories, lecture rooms and other buildings.

A novel suggestion in the financial part of the report is that money received by a university for services rendered should not be included in its annual income and expenditure account, but should be paid into a capital account, so that the finances of the institution should not be embarrassed when the services cease to be rendered and the income from this source comes to an end. The earnings mentioned in the report are those of certain medical and scientific departments, but the proposal might perhaps be extended to cover the net profits (if any) from external and school examinations.

Universities are rightly zealous in safeguarding their autonomy, and, in some quarters, fears have been expressed that increased Treasury grants might involve some form of Government control. The British Association Committee states that "the question of control by the Government is certain to be raised", but is of the opinion "that the universities will be strong enough to resist any harmful requirements which the Government might be tempted to couple with substantial increases in State grants". While holding strongly that university autonomy must be preserved, we believe that it would be advantageous to university education generally if a definite lead were given in regard to the directions in which expansion of university activities is most desirable. In the last few months all universities have submitted to the University Grants Committee their schemes for post-war development, and it is hoped that, in due course, large sums will be forthcoming to finance these. It is perhaps unlikely that the total cost of all the developments contemplated will be provided from Government sources, and it seems desirable that when a university is allotted a grant it should be informed which, if any, of the items in its programme are considered to be unnecessary in the national interest, and which are the particular developments in respect of which support is given.

The duties in connexion with the work of advising the Treasury in the distribution of the Government grant to universities have been carried out for twenty-five years by the University Grants Committee in a manner generally recognized as being altogether admirable, and which has won the full confidence and gratitude of the universities themselves. It surely merits much higher commendation than the somewhat grudging praise given in the British Association Report: "We are of the opinion that the University Grants Committee has done very well in the inter-war years".

The report stresses the desirability of the creation of a universities' advisory council, which should include the vice-chancellors of universities and the principals of university colleges, university teachers of various grades and persons of distinction in other walks of life. The council would have the duties of formulating a national policy of university education and research, of advising the universities on all the national and international aspects of British university problems, and of making representations to the official body which advises the Government on the financial needs of the universities. It seems to us that a committee so constituted would be unwieldy in size, difficult to assemble and unlikely to be able to function usefully in the directions suggested. Moreover, it would be redundant in view of the existence of the Committee of Vice-Chancellors and Principals, and of the Universities Bureau of the British Empire, which latter body will doubtless be considering whether any extension of the range of its activities is desirable having regard to the conditions which will prevail after the cessation of hostilities. The University Grants Committee has recently been reconstituted and enlarged. It has always been able to command such additional expert advice as it has needed from any academic or Government source. It is in constant touch with the Committee of Vice-Chancellors and Principals, which already fulfils some of the functions set forth above. Moreover, individual universities are often in consultation with Government departments on matters of national and international importance, and it is right that this direct consultation should continue.

One wonders whether those who are pressing for the establishment of a universities' advisory council are really aware of the many claims which are made on the time of a vice-chancellor or of other persons who are specially qualified to speak on university matters. It is important to guard against the danger of such an increase in the time occupied by attending meetings that those who regularly fulfil their duties in this respect become automatically less qualified to offer advice, because of their enforced detachment from their primary duties in their universities.

# PROBLEMS OF MODERN PHYSICS*

By Prof. J. FRENKEL

THE War has shown up sharply the value of physics, and its achievements in the practical and in particular the military sphere. It is not in vain that from the moment the treacherous attack upon the U.S.S.R. began, the physics institutes of the U.S.S.R. (as of all combatant countries) were switched over, almost completely, to the solution of defence problems.

Although these problems are also basic problems of present-day physics, I shall not touch upon them at all here. My task is in brief to survey the 'normal' problems of modern physics, that is, those problems which physics sought to solve in peace-time, and to which it will return after the end of the War.

These problems can be divided into three groups:

(1) *Problems of theoretical physics.* These comprise, in the main, the explanation of phenomena which were discovered and studied experimentally some time ago. In a series of cases, however, theory has preceded experiment and predicted phenomena or laws which had been previously unknown. The most striking achievements of theoretical physics are among this type of prediction. It must be noted, however, that these predictions were in almost every case the outcome of a theory which aimed not at forecasting new, but at explaining old, phenomena. Outstanding theoretical workers have been able by this re-examination of old data to see in it features other than those which were thought to be known and understood.

A characteristic feature of any new theory, which does not try to fit new facts to an already established representation, but attempts a broader representation of the old as well as the new facts, is its irrationality from the point of view of previous ideas. This irrationality disappears only after these old ideas have been radically reconstructed. Striking examples of such 'revolutionary' theories in physics are Newton's theory of gravitation, Maxwell's electromagnetic theory of light (which predicted the existence of wireless waves), and the quantum theory of Planck, Einstein and Bohr.

(2) *Problems of experimental physics.* Here, as in the domain of theoretical physics, it is possible to distinguish two types, namely, the discovery of new things and phenomena (for example, X-rays, radioactivity, the neutron, the positron, etc.) and the detailed study of phenomena of which the general features only are already known. At first sight it would appear that we can discuss problems of the second kind only, because no one can know beforehand anything about phenomena which are still undiscovered. However, the conception of novelty allows a series of gradations, and if we have in view not only radically new phenomena, but also those which are in principle similar to ones observed previously, the search for such new phenomena can be included in a plan of scientific investigation.

(3) *Problems of technical physics.* Experimental physics is closely connected with theoretical physics on one hand and with technical physics on the other. In both cases this connexion has a two-sided character; that is, the respective parts of physics mutually condition and stimulate each other's development. In the realm of technical physics, we are concerned, generally speaking, with questions of utilizing the achievements of experimental physics for technical and, in particular, for industrial ends. In a number of cases, however, progress by technicians leads to the creation of new apparatus and methods of investigation, which open up new lines of development for experimental physics. Thus, for example, the development of radio-technics, which was the result of success in the study of electromagnetic and electronic phenomena, led in its turn to the creation of apparatus (electron counters, the electron microscope, the automatically operated Wilson chamber, the cyclotron) to which we are indebted for new knowledge in nuclear physics.

## Physics of Material Bodies

A discussion of the problems of modern physics could be based on the classification introduced above. It is more convenient, however, to make a division into two groups of a different kind: problems of a macroscopic character connected with the properties of material bodies; and problems of a microscopic character, dealing with elementary processes and elementary particles of matter, and the nature of matter itself. The tasks and methods of theoretical, experimental and technical physics can be rigidly separated into the two groups under consideration.

The physics of the nineteenth century studied successfully the external side of phenomena, which was directly accessible to experiment and observation. The physics of the twentieth century successfully concentrated its attention on the internal mechanism of these macroscopic phenomena, that is, on their microscopic essence. In this way it had succeeded by the beginning of the 'thirties in explaining all phenomena in terms of the movement and mutual interaction of unchangeable elementary particles of two kinds, electrons and protons, in agreement with the general principles of quantum mechanics on one hand, and of electrodynamics on the other. As a result, it was possible either to establish theoretically and verify experimentally or to establish experimentally and explain theoretically, the structure and properties of those ninety-two kinds of atoms from which all material bodies known to us are constructed.

By the structure of atoms I have in mind the number, arrangement and movement of electrons around their respective nuclei, which for the majority of physico-chemical questions can be treated as positively charged point particles. Within the framework of this scheme, the structure of the atom was studied experimentally and theoretically with as much thoroughness as, for example, the structure of our planetary system.

New problems are connected with the deep study of the structure and properties of the atomic nucleus, and also with the process of its transformation—the alchemists' dream of artificial 'transmutation of atoms', now accomplished although only under laboratory conditions. From the other side these new problems are connected with the more detailed study of the system which depicts atoms in their combinations one with another—as molecules, crystals and amorphous bodies.

The development of atomic physics in each of these two directions has a completely distinctive character. In studying molecules and material bodies, physics is dealing with phenomena which have been studied experimentally, and in part theoretically, for many

* Translated by E. R. Holmberg from *Vestnik Acad. Sci., U.S.S.R.*, 4–5 (1943), made available by courtesy of the Science Section of the Society for Cultural Relations with the U.S.S.R.

years, although from a more or less macroscopic and therefore inadequate point of view. The problems of modern physics in this domain consist principally of the theoretical explanation of accumulated facts, from a microscopic point of view, that is from the point of view of the modern picture of the structure of atoms and the behaviour of their constituent electrons and nuclei.

The application to these questions of quantum mechanics and electrodynamics had already led, if not to a quantitative then, in a large measure, to a qualitative explanation of the various phenomena. Modern physics has succeeded in laying the basis of quantum chemistry, and in determining the structure and properties not only of simple but also occasionally of complicated organic molecules and crystals. Here, in the majority of cases, physics has only confirmed or completed those ideas which were worked out earlier by chemists, at times just by feel, on the basis of indirect evidence.

It must not be thought, however, that all this progress was achieved in the realm of theoretical physics. X-rays and cathode rays (electrons) are powerful tools for experimental investigation into the structure of molecules and material bodies. But all the basic problems concerning the structure of systems more complicated than atoms, that is, consisting of several or many atoms, have a theoretical rather than an experimental character.

The modern theory of the structure of molecules and crystals is still very far from the stage of exactness which is achieved in the description of the structure of separate atoms. At the moment, there lies before physics the very wide (although perhaps not very profound) problem of the more quantitative development and clarification of our knowledge. Besides these structural problems, there lie beyond still further unsolved problems connected with the study of the processes which take place in molecules and material bodies under the influence of various factors, such as mechanical action, heat and cold, electric and magnetic fields, light, etc.

Problems of this kind by no means always need for their solution a detailed application of the ideas and methods of atomic investigation. In particular, this is true of problems concerned with the mechanical properties of solids and liquids (or more precisely of crystalline and amorphous bodies). Here can be observed a marked lagging of theory behind experiment and technical practice. It is sufficient to say that, until the present time, we have had no satisfactory theory of such well-known and practical phenomena as the friction of solid bodies; no quantitative theory of the plastic properties of crystals, that is, of their 'flow' under the action of sufficiently strong tension. Our ideas about the mechanical properties of solids and liquids have remained until the present time extremely simple and schematic.

Liquid bodies possess the properties of elasticity of volume, and viscosity under change of form. In recent times it has become apparent that liquids, besides having volume elasticity, also possess elasticity of form similar to a solid body; that is, besides plasticity, they possess rigidity, the latter being masked usually by the former. Further, a series of bodies has been studied which possess unusual properties, and which cannot be put into either of the traditional categories of liquids and solids. An example of these is resin, and other 'resinous' substances with a high elasticity which disappears at low temperatures, and also jelly-like liquids which have a wide application in the technics of to-day and possess completely individual elastic and plastic properties of structural origin.

The whole question of the 'unusual' mechanical properties of these substances, which are fortunately in most cases connected with their unusual electrical properties, is proof enough that a study of them from a theoretical as much as from an experimental point of view represents one of the tasks awaiting modern physics.

At temperatures near absolute zero, liquid helium occupies a certain peculiar position among these unusual substances. The striking experiments of Kapitza have shown that near the absolute zero of temperature helium completely loses the viscosity characteristic of normal liquids. As an explanation of Kapitza's experimental results, Landau has published an extremely interesting quantum treatment of the hydrodynamics of helium, based on the postulate that there exist two phases in liquid helium, a 'dead' non-viscous phase and a 'live' one possessing finite viscosity.

Landau's theory is in certain respects as unusual and 'irrational' as the experimental result it explains. But this is not sufficient to condemn it as a failure, because, as explained above, every new theory appears at first to be more or less irrational. However, the irrationality of a theory is not enough in itself to confirm its correctness. This can only be done by extending it to cover other phenomena, and then verifying its predictions experimentally (for example, in the case of liquid helium the proof of the theory is connected with the existence of two different velocities of sound in helium).

The absence of viscosity in liquid helium near the absolute zero of temperature is a mechanical analogue of the phenomenon of superconductivity, that is, the disappearance of electrical resistance, in a number of metallic bodies, at very low temperatures. Although this phenomenon has been known for some time, there is still to-day no satisfactory theoretical explanation of it, if we exclude certain attempted explanations of the fact that it occurs in two stages. The discovery of this explanation remains one of the real problems of modern physics, and in all probability it will need a basic alteration of our ideas concerning the normal conductivity of metals, along the lines of a more correct consideration of the mutual interaction between 'free' electrons, which condition this conductivity.

At the present time there is still great urgency about problems connected with the electrical, optical, photo-electric and thermo-electric properties of semi-conductors of electricity, in spite of the great progress achieved in this sphere in recent years, particularly by Soviet workers such as A. F. Joffe and his school. These substances occupy an intermediate position between metals and dielectrics, just as liquids are intermediate between solids and gas-like bodies. As a rule, they become more like insulators at low temperatures and like metals at high temperatures. The effect of temperature is to produce ionization; that is, it tears off the bound electrons, which can then move freely throughout the whole crystal and thus conduct an electric current. Radiation also serves as an ionizing agent, not only in the visible but also in the infra-red region. Under the influence of unequal illumination or heating, appreciable photo-electric and thermo-electromotive forces arise in semi-conductors.

At the present time, physics has to a large degree

learned how to manage the various properties of semiconductors principally by the method of adding to them a mixture of atoms which either easily give up their own electrons or quickly capture foreign ones. The development of this new domain of physics has already produced results of enormous industrial and technical value, although the future promises still more important technical applications. Perhaps it will be semiconductors which will help mankind to solve a basic technical problem in the not distant future when the deposits of accessible fuel coal and oil are exhausted. I have in mind the problem of utilizing directly the sun's energy by converting it into electrical energy by means of photo- or thermo-elements. The preliminary results obtained before the War by A. F. Joffe and his fellow-workers show that this idea is not Utopian, because the efficiency of rationally constructed photo- and thermo-elements is very high (this efficiency is appreciably greater in the case of semiconductors than in that of metals).

But from the purely scientific point of view, the study of semiconductors is still far from complete, and there are a number of very interesting problems connected with the subject which are as much theoretical as experimental. Among these must be mentioned that of 'localized' but free electrons in a crystal lattice, undistorted except for these electrons. Connected with this is the question of the motion of slow electrons and the existence of 'excitons,' that is, freely movable centres of electron excitation. This last question has particular importance for the understanding of the mechanism of certain photo-chemical processes in crystalline dielectrics. It acquires special interest in connexion with a new method of testing insulators electrically, which was put forward recently by B. I. Davidov. According to this method of testing gases, ionization takes place in stages, that is, the ionized atoms are first excited (just as in excitation, the ionization is caused by collisions of atoms with electrons which were freed as a result of a previous ionization). This hypothesis seems very plausible to me, although it cannot be accepted without further quantitative experimental verification. In particular, however much the gas test resembles the test for solid dielectrics, Davidov's hypothesis postulates the existence of free electrons (that is, excited atoms) in these solid dielectrics.

The intermediate role of semiconductors is analogous to that played in magnetism by the so-called meta-magnetic bodies such as magnetite and also a large number of chemical compounds of magnetic with non-magnetic elements. At moderate temperatures these bodies behave like ordinary ferromagnetics, but they lose their magnetic properties not only at high temperatures like ordinary ferromagnetics but also at low temperatures. This as yet little studied phenomenon of 'meta-magnetism' has probably an important practical application besides its great scientific interest. In particular, there is great practical value in the further study of the problem of obtaining ferro-magnetic, or rather meta-magnetic, alloys from non-magnetic elements. At the present time, only a few such alloys are known, and they possess very interesting magnetic properties. It is interesting to note in this connexion that there is an analogy with superconductivity. We now know of a series of superconductors (at low temperatures) which are alloys of elements not themselves superconductors.

The study of meta-magnetic phenomena requires the use of very low temperatures, although not so low as for the study of superconductivity, and the analogous problem of the disappearance of viscosity. These very low temperatures are also required for investigations into the optical properties of crystals, in particular for spectral analysis, and a large number of other properties of solid bodies which only become important in exceptional cases. Therefore one of the necessary subsidiary tasks of physics is to equip institutes with cryological laboratories and to improve further the methods of low-temperature work. (At the present time it is possible by magnetic methods to achieve temperatures of the order of one thousandth of a degree absolute.)

It must not be thought that interesting and little-known properties of solid bodies can only be demonstrated by means of super-low temperatures. In recent years there has accumulated a wealth of experimental material relating to transformations observed in crystalline bodies at medium and high temperatures. In contrast to ordinary allotropic or polymorphic transformations connected with changes in crystal structure and the emission or absorption of heat, 'transformations of the second kind' about which I am thinking only make themselves apparent by anomalous changes, over a fairly narrow interval, in specific heat, coefficient of expansion and a series of mechanical, electrical, magnetic and optical properties.

Similar transformations were first established by observations in the case of ferromagnetic bodies near the so-called Curie point, above which their ferromagnetism disappears. This is a phenomenon similar in character to the disappearance of superconductivity at low temperature, that is, the restoration of normal electrical conductivity, and to the transition of liquid helium from its anomalous modification II having no viscosity to the normal phase, helium I, with a finite viscosity.

Analogous transformations of the second kind were recently brought to light in certain metallic alloys. As was first shown by Bragg and Williamson, these transformations occur when the regularity of the relative positions of the different kinds of atoms breaks down. Thus, for example, in an alloy of zinc and copper in equal proportions, the atoms are arranged in a chessboard pattern at low temperatures, but at a transformation at a certain temperature analogous to the Curie temperature in ferromagnetics this alternating arrangement completely disappears.

Further, a series of crystalline substances is known, for example, compounds of halogens with hydrogen, methane and other paraffins, in which these second order transformations can be traced—wholly or in part—to disordering of the particles (or as Pauling thinks, in certain cases to the molecules changing over from oscillatory motion about regularly distributed equilibrium positions to free motion as in gases). These analogies do not, however, cover all the observed phenomena. Thus, for example, in the case of hydrogen chloride, one Curie point is observed which can be attributed to the molecules becoming disordered (or according to Pauling, to the transition to free motion); but in the case of hydrogen bromide, there are three such transformations.

Thus we can see that the experimental and theoretical study of second order transformations in crystalline bodies represents for modern physics a wide and as yet far from exhausted problem.

The formulation of a theory of the liquid state is a wide and urgent problem for theoretical physics.

Early attempts at a solution of this problem used the kinetic theory of gases and treated liquids as highly compressed gases. In more recent times the tendency has been to liken liquids more to solid bodies, lacking the greater orderliness in the arrangement of their particles, but still possessing that close packing which characterizes the crystalline type of structure. Since the liquid state is intermediate between the solid and gaseous states, it is natural to expect that the similarity between liquids and compressed gases becomes more or less exact at high temperatures (close to the critical temperature) and that at temperatures near crystallization liquids resemble solids. This kind of description, borrowing from the kinetic theory of gases on one hand and from the kinetic theory of crystals on the other, is, however, only an interpolation, having a limited value. There are sceptics who think that, in view of the great complexity of the problem, physics is only handicapping itself in explaining the structure and properties of liquids by such interpolations. Personally, I consider, however, that this scepticism is unjustified, and that further work towards perfecting the kinetic theory of liquids is one of the real tasks of physics in our time.

It must be mentioned that the performance of this task leads immediately to the necessity of radically altering our traditional ideas about the fluid state of bodies, first of all with the aim of removing the contradiction between the concept of plasticity and rigidity. As already explained above, the first of these does not exclude the second but only masks it. It is necessary, moreover, to bear in mind that the division of bodies, or rather aggregate states of substances, into solids and liquids does not accord with reality, which provides an extremely complex profusion of such states. Besides the liquid-crystalline (or mesomorphic) state which has already been studied thoroughly from the experimental side, modern physics knows of states which it is impossible to fit into the 'solid and liquid' scheme; for example, the resinous state, which as shown by very recent investigations can be encountered in such simple substances as sulphur and phosphorus. To phenomena such as these must be added the various jelly-like states which have hitherto scarcely been studied. But among those to whom the study of jelly-like systems (gels) presents enormous interest are the biologists, for recently physics has begun to penetrate into their sphere through the peculiar intermediate science of biophysics. So we see that one of the fundamental problems of modern physics is the experimental study of complex aggregate states and the construction of a molecular-kinetic theory for them.

The development of all natural sciences is closely bound up with the improvement of the apparatus with which natural phenomena are observed and which produces phenomena not encountered under natural conditions. In this respect physics differs from other sciences, for it creates new apparatus in connexion with new methods, not only for other sciences but also and in the first place for itself.

We have already mentioned above the remarkable phenomena of superconductivity and the disappearance of viscosity, which were discovered through working out methods of achieving very low temperatures. In this direction—the approach to absolute zero—physics has still, apparently, not reached finality; a number of properties of material bodies connected with the magnetic moments of nuclei need for their experimental observation and study still lower temperatures—of the order of one ten-thousandth part of a degree and lower. Physics has the means with which to do this (by using the magnetic moments of atoms and nuclei) but has still to use them fully. This is work for the near future.

In the region of high temperatures, modern physics has still not progressed very far. The maximum temperature achieved in the laboratory is somewhere around 20,000°, although as yet it has not been possible to observe the properties of any bodies at this temperature. In this respect more interesting results have been produced by astrophysics.

In recent times extremely important results have been obtained in high-pressure work. A few years ago, Bridgman succeeded in producing pressures up to 50,000 atmospheres, and further was able to study their effect on a series of properties of solids. More recently still, it has been possible to raise this limit to around 100,000 atmospheres, that is, approaching the order of pressures (about one million atmospheres) which prevail at the centre of the earth. One of the urgent tasks of experimental physics is to study further the properties of matter at these extreme pressures.

Besides these achievements in the realm of super-high pressures and super-low temperatures, physics has in recent years much increased the power of its observations by creating and applying the electron-microscope. Ordinary microscopes give a magnification not exceeding five to six thousand times. With the help of the electron-microscope it has been possible to increase this limit a thousand-fold, that is, to reach a linear magnification of the order of one million. The application of the electron-microscope has already produced a number of remarkable results in physics, metallography, colloidal chemistry and in particular in biology, for it has made possible the observation of individual 'molecules' of certain pathogenic viruses; apparently these molecules are able to grow and multiply, and represent forms intermediate between ordinary crystals and living organisms. The study of the new 'ultra-microscopic world' discovered by the electron-microscope will in the near future be one of the most important and fruitful tasks of so-called higher science. At every stage it brings forth new discoveries and sheds light on phenomena which were known before only incompletely. In this the electron-microscope will play as great a part as did the ordinary microscope in its time. A whole series of objects ranging from those of microscopic size of linear dimensions of the order $10^{-4}$ cm. down to particles not much larger than molecules now becomes accessible to direct observation and investigation. This is the domain which is of immediate interest for the sciences both of living and dead material.

Finally, there is still one more branch of physics which seems likely to make noteworthy progress. I am referring to the increases in frequency of artificially produced electrical and mechanical vibrations (ultra-short radio waves and ultra-sonic waves). Modern radio technics has succeeded in producing frequencies of the order of $10^9$ per second, which correspond to electromagnetic waves with a wave-length of less than 1 cm. However, between these radio waves and those of infra-red heat, there still remains the practically unexplored interval of wave-lengths ranging from some millimetres to a tenth part of a millimetre. But it is just this interval which is so interesting for the study of the electrical properties

of liquid and solid dielectrics (for example, absorption and dispersion should be very large). This interval of frequencies also presents great interest for the study of the mechanical properties of solids and more particularly liquids. This can be done by investigating the propagation through them of artificially produced ultra-sonic or hyper-sonic vibrations the frequency of which approaches that of their heat movements. The process of transforming electrical into mechanical vibrations has already been worked out; what remains is to increase further the frequency of radio-waves. During the last three or four years there has opened up a new way of attacking this interesting and important work by the use of klystrons and other electronic apparatus.

Summarizing, we see that the most interesting problems in physics are those connected either with limiting or with intermediate properties of material bodies. This conclusion holds also for other sciences besides physics, and further, the most topical problems are concerned not with those phenomena which are studied by definite specialized sciences, but with those borderline phenomena which fall between them. It is thus perfectly natural that these problems, besides being the most complicated, are also the least studied. A particular example of this is biophysics, the problems of which have been intensively studied by physicists for some time. In recent years, physics has attracted biologists to help in the solution of these biophysical problems, but physicists have not themselves shown much interest (if we except the physiological aspects of optics and acoustics). I am inclined to think that in the very near future this position must undergo a definite change, and that this part of the science front must conduct an extensive battle for new knowledge. I shall not attempt to enumerate the problems of biophysics because they are innumerable. Besides problems about the properties of gels mentioned above, there are those concerning photosynthesis, nervous and mental activity and electro-physiology (in particular, electrical vibrations in the brain). Finally, not the least interesting problem is that of the mechanics of living organisms (for example, the locomotion of animals and insects).

Not long ago, physical chemistry occupied the intermediate position which is now occupied by biophysics. At the present time, the formerly borderline phenomena have been completely assimilated into physics.

In its impetuous rush of growth, physics has of course been unable to prevent itself encroaching on the region long considered the province of chemistry. In distinction from chemistry, which is a science of materials and their transformations, physics, like sciences of other phenomena connected with matter, has lost this sense, by 'going behind' chemistry in discovering the structure of the chemical atom-elements and showing how to cause their artificial transmutation. In this way, chemistry has become a branch of physics, though it is true one of the largest, most interesting and practically the most important branch. In an exposition of the problems of modern physics, it would therefore be quite appropriate to include also the basic problems of chemistry. I shall, however, leave those problems which belong to chemistry in its narrow sense and pass on to those of the modern 'alchemy' which concern the atomic nucleus.

*(To be continued.)*

# OBITUARIES

## Dr. W. A. K. Christie

HIS numerous friends will receive with the greatest regret the news of the unexpected death of Dr. William Alexander Kynoch Christie, which took place in London on June 16, after a very short illness.

Christie was the youngest son of Charles Robert Christie and Margaret Catherine Paterson, both of Edinburgh, where he was born on October 2, 1882. He was educated at Daniel Stewart's College and Heriot's, Edinburgh, and then in succession at the Universities of Edinburgh and Zurich, where he took the degrees of B.Sc. "with special distinction in chemistry", and Ph.D. respectively.

After acting as Prof. Crum Brown's private assistant, Christie went to the Mond Nickel Co. in South Wales, until he was appointed to the staff of the Geological Survey of India to fill the newly created post of chemist to the Department. He took up his appointment in Calcutta on November 17, 1906. This he held until his retirement from the service on October 10, 1932, after a service of nearly twenty-six years, of which slightly more than five years was spent away from the Department. Of this, nearly two and a half years was during the War of 1914–18 in the Indian Army Reserve of Officers, from which Christie was drafted to the Special Reserve of the Royal Engineers in France, where his chemical knowledge was used in the service of his country.

With other officers of the Geological Survey who had gone to the War he was recalled in 1917, owing to the growing realization of the need of geologists and chemists to help in the production of war minerals. In April 1918 Dr. Christie's services were placed at the disposal of the Government of India in the Finance Department, whereon he was posted to His Majesty's Mint, Calcutta, as deputy assay master, later acting as assay master. He reverted to his post in the Geological Survey at the end of 1920.

In 1936, after a few years in retirement in England, Dr. Christie was again employed by the Government of India, this time as civilian technical officer in the Principal Supply Officer's Committee (India) under the Defence Department, India. He was in England on deputation at the outbreak of war in 1939 and was retained at the India Office, where he was still described as a civilian technical officer, a post he held until his death. In 1930 Christie married Miss Winifred Davidson, who survives him.

Christie's scientific activities were not confined to his official appointments, as is shown by the fact that he was a fellow of the Royal Institute of Chemistry, a member of the Institution of Mining and Metallurgy, a fellow and, in 1927, president of the Asiatic Society of Bengal.

Christie was one of those specially useful men of science who are qualified in two sciences, in his case chemistry and geology. While his chemical knowledge took priority and justified his various employments outside the Department, his wide knowledge of geology and mineralogy made him a valuable member of the Geological Survey of India, as he was often able to offer sound advice both to individual officers and to his director on problems involving both chemical and geological knowledge. With this scientific versatility Christie combined a proficient knowledge of French and German, both spoken and written, and an interest in the literature of both countries.

An additional facet of this versatility was Christie's

wide knowledge of, and sympathy for, his fellow men. Not only did these qualities cause him to give help unobtrusively to 'lame ducks' both inside and outside the department—no one ever asked his help in vain—but it also caused successive directors of the Survey to value his opinion on matters not strictly chemical or geological. They also made him a valued member of club committees (the Bengal United Services Club, Calcutta, of which he was at one time president, and the East India and Sports Club in London). Everyone who knew Christie will remember his ready wit and mastery of apt phrase. As an example one may recall that on one occasion the late H. S. Bion, very early in his service, telegraphed from the field that he had at last discovered calcareous algæ in the Lower Eocene of Burma. Christie suggested that the director should reply "The whole Department shares your ecstatic joy".

As chemist to the Geological Survey of India much of Christie's time was used on routine work and work for other officers; but on all occasions where ingenuity was needed he proved to be a prince of experimenters, the accuracy of whose work could be trusted to the last recorded decimal.

The total amount of work published from Christie's pen is small, but it is of the highest quality. His greatest achievement was the sampling of the winds of the Rajputana desert during the hottest season of the year, when shade temperatures up to 120° F. and more are registered. The then director of the Geological Survey, now Sir Thomas Holland, had instituted a detailed study of the salt reserves of Rajputana, particularly of Sambhar Lake. He had decided that a probable explanation of this large accumulation of saline materials was carriage by hot-weather winds from the salt-encrusted arm of the sea known as the Runn of Cutch. Christie volunteered to test this hypothesis and went to Pachbadra (intermediate between the Runn of Cutch and Sambhar), where he was aided by the late Rao Bahadur M. Vinayak Rao. All Christie's instrumental ability was brought into play, and, using methods that he had first worked out and apparatus that he had designed and tested in the laboratory in Calcutta, he sampled the wind at Pachbadra during April–July 1908. As a result he was able to show that during the hot weather of that year the amount of sodium chloride in the form of fine dry dust coming from the south-south-west that passed a front 300 km. broad and 100 m. high during the four hot-weather months might be indicated as 130,000 tons. This was in a year when the hot weather winds were unusually weak, so that this figure is probably well below the annual average influx of salt dust. The results of this study are discussed in a joint paper by Holland and Christie (*Rec. Geol. Surv. Ind.*, **38**, 154; 1909).

Christie also visited and discussed the soda lake of Lonar in Berar, and the well-known salt deposits of the Salt Range, in the latter case studying specially the potassic layers.

Another investigation of some interest was of a white efflorescence collected by me at the fissured surface of the Barari colliery, Jharia, then on fire underground. The mineral proved to be cryptohalite, a fluo-silicate of ammonium previously found only at a Vesuvian fumarole; its occurrence, with native sulphur, recalled the long-abandoned hypothesis that volcanoes owed their activity to the combustion of coal underground (*Rec. Geol. Surv. Ind.*, **59**, 16, 233; 1926).

L. L. FERMOR.

## Sir John Jarmay, K.B.E.

THE death of Sir John Gustav Jarmay on August 22 at the age of eighty-seven probably removes the last of those heroic figures who, with Ludwig Mond and John Brunner, struggled to found the ammonia soda industry in Great Britain and in the end established our greatest and most successful chemical industry. A Hungarian by birth, he studied at Zurich and came to England in 1875, working for a short time with Roscoe before he obtained a junior position with Greenall Whitley, the Warrington brewers. Ludwig Mond, who lived at first outside Widnes and later at Winnington, must have come across him and brought him in to help in 1877, four years after the start. It is a pity that no one has put these early days on record, days of continuous effort round the clock, of many failures and difficulties and always the courage of Ludwig and Frieda Mond to try again. Another helper was Carl Markel, tutor to Robert and Alfred Mond, a swarthy Stuttgarter of great originality. Jarmay made good and was chief technical manager when Brunner Mond was formed as a company: eight years later he joined the board of the company.

The expansion was rapid, but the technical progress was veiled in reticence and only through patents, many of which bore Jarmay's name, could the outside world glimpse what was happening. Close contact was kept with Solvays at Brussels, and there were developments in the United States and elsewhere, but the real hub of alkali progress was at Winnington. There Jarmay reigned and led a loyal and expanding team. When Ludwig Mond died in 1909, Jarmay took on added responsibility, and he continued to hold the reins firmly until the formation of Imperial Chemical Industries, Ltd.

Naturally he was one of the first consulted by Lord Moulton in 1915, and assumed responsibility for the production of nitrate of ammonia, T.N.T. and phenol. He achieved much and was recognized by the award of the K.B.E.: about the same time the war services of his wife earned her the D.B.E.

It is to Jarmay's credit that the need to establish nitrogen fixation plant in Great Britain was recognized as one which Brunner Mond were in honour bound to study, though it was a task outside their normal business and bound to be arduous and costly. The great works at Billingham and elsewhere to-day are a monument to his wise decision.

Jarmay was married in 1882 to Charlotte Elizabeth Wyman, a lady of great charm, who was of the utmost assistance to him: she made their house at Hartford Lodge the social centre of the staff. She died in 1938.

Jarmay the man looked an aristocrat to the fingertips. He hunted a good deal and was noted for his immaculate appearance in the hunting field—locally he was affectionately known as "The Squire". He spent his holidays abroad, being never more happy than when among the mountains and snowfields. On his retirement he lived in Italy until the outbreak of war.

E. F. ARMSTRONG.

## Mr. Henry W. J. Hathaway

HENRY WILLIAM JOHN HATHAWAY, who was killed accidentally on July 4, was born in London on October 27, 1915. He was educated at the Polytechnic School, Regent Street, London, and at the Imperial College of Science and Technology, South Kensington, where he read chemistry and geology, and took his B.Sc.

(Honours) in 1939, as a result of which he was granted his A.R.C.S.

Hathaway first held an appointment with Messrs. Murex Welding Co., Ltd., towards the end of 1939, working on the technology of tungsten. In January 1940 he joined the Fullers' Earth Union Ltd., Redhill, Surrey, as works chemist. Here he had full scope for his ingenuity in the development of chemical engineering processes. For many months he worked on an effluent treatment plant, assisting in its design, erection and eventual working, and carried out research into the utilization of the gel-like product. He worked hard to increase his theoretical knowledge of chemical engineering, and showed a remarkable flair for imbuing workmen with interest and enthusiasm. He could undertake almost any plant operation with his own hands, and was adept at making laboratory apparatus.

In July 1943 he joined Messrs. Bound Brook Bearings (G.B.), Ltd., Birmingham, where, as chief chemist, he supervised the installation and starting up of a new experimental laboratory. After a period as assistant to the works manager, helping on production problems, he began a comprehensive programme of experimental work on powdered metals. He took an active interest in the social side of works life.

Hathaway tried his hand at everything; he had a great thirst for experience. He was impatient with unnecessary delays and detested waste in factories or slackness in men. His creative urge, versatile hands and wide general knowledge would have carried him far, and industry has lost an unusually promising young life. He had been married only three months and is survived by his widow and his parents, of whom he was the only son.

ROBERT H. S. ROBERTSON.

WE regret to announce the following deaths:

Prof. Harry Berman, associate professor of mineralogy at Harvard University, on August 28, aged forty-two.

Mr. H. P. Marks, a member of the scientific staff of the National Institute for Medical Research for the past seventeen years, on September 13.

Sir Humphry Rolleston, Bt., G.C.V.O., K.C.B., during 1925–32 regius professor of physic in the University of Cambridge, on September 24, aged eighty-two.

Mr. W. H. Ross, O.B.E., formerly managing director and chairman of the Distillers Company, Ltd., and founder of the Ross Research Foundation for the Study and Prevention of Blindness, Edinburgh, on August 22, aged eighty-two.

# NEWS and VIEWS

## Mr. T. Raymont

MR. T. RAYMONT, the well-known educationist, celebrated his eightieth birthday on September 27. at his home in Carbis Bay, Cornwall. As an educationist, Mr. Raymont began his career in the chair of education in University College, Cardiff, in 1890, where he remained until 1905. He was then appointed vice-principal and later warden of Goldsmith's College (University of London), where he remained until 1927. There Mr. Raymont did some splendid work in the development of that College. During the difficult times of the War of 1914–18, he saved the College from extinction by his perseverance and common sense and above all by his absolute faith in its future. By his personal efforts he secured its survival and development in a greatly extended form as a training college for all branches of education. During that time, therefore, his reputation in the educational world became wholly established and his advice was keenly sought after. He was educational adviser to the National Froebel Union for eight years, besides being chairman for an even longer period. In 1928 he was president of the Training College Association and also of the Froebel Society. Perhaps Mr. Raymont's most well-known publication was "Principles of Education", which first appeared in 1904 and became a standard work that has passed through a large number of editions, the latest of which is still in demand. Other publications were "The Use of the Bible in Education", "Modern Education", and "The History of Education in Young Children". For many years Mr. Raymont has written in the educational journals. He has also been a regular contributor to *Nature*, and still is.

One of Mr. Raymont's daughters, who was formerly on the scientific staff of the Wellcome Historical Medical Museum, is the wife of Mr. H. J. Braunholtz, keeper of oriental antiquities and ethnography in the British Museum, and a past president of the Royal Anthropological Institute. Mr. Raymont's educational interests are shared also by Mrs. Raymont and two other daughters, all of whom have taught or are teaching in schools. We are glad to record that Mr. Raymont is enjoying excellent health, and still keeps in close touch with the general progress in education and science. The War has unfortunately interrupted his visits to London; but, in addition to his literary work, he finds a fruitful outlet for his energies in local educational affairs and in serving on the committee of the Penzance Library. We offer our congratulations to Mr. Raymont, and hope that for many years to come he will live to enjoy a very active life and continue to give educationists and men of science the benefit of his very wide knowledge and long experience.

## Chair of Zoology at Bristol

PROF. J. E. HARRIS, who succeeds Prof. C. M. Yonge in the chair of zoology at Bristol, has for some years been a University demonstrator in zoology at Cambridge. He is well known for his versatile contributions to experimental zoology, among which perhaps the most noteworthy is his analysis of the functions of the paired and unpaired fins of fishes. He has, however, also made highly original contributions to the physical properties of living cells, which may be expected to lead to results of widespread significance. Most of Prof. Harris's work has been carried out in Great Britain, but prior to the War he spent two years in the United States as a Commonwealth Fellow. For the past three years he has been in charge of a research unit under the Iron and Steel Institute. Prof. Harris may be expected to exploit to the full the admirable facilities which the Univer-

sity of Bristol has provided, in recent years, for the study of experimental zoology. The appointment of a man of Prof. Harris's wide interests and experience may be regarded not only as a source of satisfaction to the University of Bristol, but also as a good augury for the post-war development of zoology in Great Britain.

## Chinese Professors Visiting Britain

FIVE Chinese professors have just arrived in Britain, and will be guests of certain colleges at Oxford and Cambridge and of the British Council. They will continue their studies with the view of making British achievements in these fields better known in China. The visitors are: Prof. Chang Tsu-Kung, of the Central China University, an authority on the history of science, who is going to Christ's College, Cambridge; Prof. Yin Hung-Chang, of the Associated South-Western Universities (Tsing Hua), Kumming, who will do research in plant biochemistry, and will reside at St. John's College, Cambridge; Prof. Chang Hui-Wen, of the Central University of China, where he taught public administration and political science, who is to study public administration in Britain in connexion with the development of the Civil Service examination system in China, and will be attached to Corpus Christi College, Cambridge; Prof. Fan Tsen-Chung, head of the Foreign Languages Department, National Central University, Shapingpa, who will undertake research in English literature (with special reference to English knowledge of China), and will reside in Balliol College, Oxford; Prof. R. C. Fang, head of the Foreign Languages Department, Wuhan University, Kiating, who will undertake research in English literature, and will reside in Trinity College, Cambridge.

## French Scientific Mission in Great Britain

THE executive committee of the Society for Visiting Scientists received the members of the French Scientific Mission on September 16 at the Society's house at 5 Old Burlington Street, London, W.1. Prof. F. G. Donnan expressed a warm welcome to the Mission, which is led by M. L. Rapkine, and includes Prof. J. Hadamard, Prof. Pierre Auger, Prof. Francis Perrin and Dr. R. Wurmser. He said that French civilization and science are an essential part of those of Europe, and, as Voltaire might have said, if they did not exist, it would be necessary to invent them. He hoped that Anglo-French scientific relations will grow at a great pace and become one of the foundations of development in the post-war period. Sir Henry Dale supported Prof. Donnan, and looked forward with particular pleasure to the prospect in the near future of Prof. Hadamard being officially admitted as a foreign member of the Royal Society.

## Research in Cotton Growing

AT a meeting of the Administrative Council of the Empire Cotton Growing Corporation on June 6 several new appointments were made. Mr. Arthur Foster was elected chairman of the Council in succession to the late Sir Richard Jackson and Mr. James Littlewood vice-chairman. The post of director of the Corporation was filled by Mr. L. G. Killby, and Mr. J. C. May was elected secretary. Mr. Killby has also been appointed chairman of the Scientific Committee. The activities of this body have largely been concerned with the arrangements for establishing the new Central Cotton Research Station in Uganda. Though actual building operations cannot begin until after the War, a satisfactory site has been selected, and it is hoped that some preliminary work on it will soon be started. Mr. Parnell and Mr. Hutchinson have been designated for the posts of director and deputy director of the new Station respectively.

The Corporation's report for 1942–43, together with the programmes of work for 1943–44 of each of its seventeen experiment stations, has been submitted in the same form as in previous war years, and can be obtained, price 3*s*., from 37 Inner Park Road, Wimbledon Common, London, S.W.19. The research station in Trinidad is being closed in order that work may be concentrated in the larger cotton-growing countries with the new Station at Uganda as a central feature. This attention to development in research was commended by the President of the Board of Trade in his message to the Corporation at its annual general meeting for, as he said, efforts to improve the quality of cotton grown in the Empire and to increase its yield per acre is a valuable contribution to the prosperity of the Empire as a whole.

## Town and Country Planning

IN view of the important part which engineers are playing and must play in all future planning, the Council of the Institution of Civil Engineers has appointed an Institution Committee to be known as "The Town and Country Planning Committee" to advise the Council on matters relating to the engineer's part in town and country planning. This takes the place of a sub-committee of the Public Relations Committee, which had been dealing with this matter previously. The new Committee will include members who are city engineers and borough surveyors and others who have specialized on roads, railways, docks, water supply, drainage including sewage disposal, and electricity and gas services.

In order to enable engineers and others to keep in touch with present-day principles and ideas in planning, the Council has also arranged a series of four lectures on "The Position of the Engineer in Relation to Town and Regional Planning" on Thursdays at 5 p.m., beginning on October 26. Particulars of the lectures are as follows: October 26, "The Basis of Town and Country Planning", by Mr. H. J. B. Manzoni, city engineer and surveyor, Birmingham; November 2, "Traffic Problems", by Mr. W. S. Cameron, city engineer and surveyor, Leeds; November 9, "Drainage, including River Works", by Mr. D. G. Bevan, deputy city engineer and surveyor, Birmingham; November 16, "Services (Electricity, Water, Gas and Post Office)", by Mr. J. Paton Watson, city engineer and surveyor, Plymouth. These lectures will be open to non-members of the Institution on payment of 2*s*. 6*d*. for each lecture. Applications for tickets, accompanied by remittances, should be made to the Secretary of the Institution.

## Rickettsia Diseases

THE March issue of the *Boletín de la Oficina Sanitaria Panamericana* contains reports concerning Rocky Mountain spotted fever and the typhus group from five members of the Panamerican Sanitary Bureau Committee on Typhus, namely, Dr. Otávio de Magalhães of Brazil, Dr. L. Pãtino-Camago of Colombia, Dr. A. Recco of Cuba, Dr. C. G. Hidalgo of Ecuador and Dr. G. Varela of Mexico. There

were, in all, 791 cases of Rocky Mountain spotted fever and 9,625 cases of the typhus group. Brazil reported 663 cases of spotted fever in the fourteen years 1929–42, occurring in thirty-six localities of three States (Rio de Janeiro, Minas Gerais and São Paulo), but the report was admittedly incomplete and consisted only of the severe forms of the disease. In Columbia there were 128 cases of Rocky Mountain spotted fever during 1934–43 in seven localities in two departments. With regard to typhus fever (type not specified), except for Cuba where all the cases were of the murine type, Brazil reported four cases in 1941, Colombia 882 cases in 1942 and the first quarter of 1943 with a case fatality of 10–17·4 per cent in hospital cases. In Mexico there were 8,198 cases of typhus during 1938–42, with 750 in Mexico City, and a case mortality of 14 per cent. In Ecuador there were 517 cases of Rocky Mountain fever and 18 of typhus.

## Fulgence Raymond (1844–1910)

PROF. FULGENCE RAYMOND, a leading Paris neurologist, was born on September 29, 1844, at St. Christophe, Indre et Loire. He first studied veterinary medicine at the School at Alfort, where in 1867 he became director of the department of anatomy and physiology. Afterwards he took up medicine in the Paris faculty under Vulpian and Charcot and qualified in 1876. In 1894 he succeeded Charcot in his hospital practice and in the chair of nervous diseases at La Salpêtrière.

Raymond was well known in Great Britain, where he was made an honorary D.Sc. at Oxford and delivered a lecture at the Royal College of Physicians on "Premature Physiological Senescence localized to certain Organic Systems". He died on September 28, 1910. His chief publications were "Anatomie pathologique du système nerveux" (1886), "Maladies du système nerveux" (1889–94) and in collaboration with Janet "Leçons sur les maladies du système nerveux", "Neuroses et idées fixes" (1898), "Obsessions et la psychasthenic" (1903), "Etudes de pathologie nerveuse" (1910). He also made numerous contributions to the *Revue Neurologique* and *L'Encéphale.*

## Appointments in the University of London

DR. C. A. MACE, University reader in psychology at Bedford College, has been appointed as from October 1 to the University chair of psychology tenable at Birkbeck College.

Prof. W. H. McCrea, since 1936 professor of mathematics at Queen's University, Belfast, and since 1943 temporary principal experimental officer in the Admiralty, has been appointed as from October 1 to the University chair of mathematics tenable at Royal Holloway College.

Prof. Frank Goldby, since 1937 Elder professor of anatomy in the University of Adelaide, has accepted the appointment to the University chair of anatomy tenable at St. Mary's Hospital Medical School, and hopes to take up his post during the session 1945.

## Tapeworms in Seagulls and Cormorants

REFERRING to the report by J. B. Duguid and E. M. Sheppard of the infection of trout in a South Wales reservoir with plerocercoids of a tapeworm belonging to the Diphyllobothriidæ (see *Nature* of August 5, p. 185), M. D. Hickey and J. R. Harris (*British Med. J.*, 310, Sept. 2, 1944) report the finding of an adult tapeworm belonging to the genus Diphyllobothrium in seagulls and cormorants in the Dublin area. They think that these birds are the naturally infected definitive hosts of the parasite in this district. Trout from reservoirs near Dublin are heavily infected with plerocercoids belonging to the Diphyllobothriidæ. In the intestines of the greater and lesser black-backed gulls (*Larus marinus* and *L. fuscus*), of herring gulls (*Larus argentatus*) and of cormorants (*Phalacrocorax carbo*) the authors found all stages of the tapeworm from the plerocercoid found in the fish to the adult tapeworm. Investigation is proceeding and further details will be published later.

## The Night Sky in October

FULL moon occurs on Oct. 2d. 04h. 22m. U.T., and new moon on Oct. 17d. 05h. 35m. The following conjunctions with the moon take place: Oct. 8d. 16h., Saturn 0·3° N.; Oct. 14d. 01h., Jupiter 3° S.; Oct. 19d. 20h., Venus 5° S. The following occultations of stars brighter than magnitude 6 take place: Oct. 4d. 0h. 18·4m., $\xi^2$Ceti (*D*); Oct. 4d. 0h. 47·9m., $\xi^2$Ceti (*R*); Oct. 6d. 1h. 57·0m., 64 Tauri (*R*). The times refer to the latitude of Greenwich and *D* and *R* refer to disappearance and reappearance respectively. Mercury rises at 4h. 38m. at the beginning of the month and is in superior conjunction on Oct. 20. At the end of the month the planet sets very shortly after the sun. Venus sets at 18h. 22m. and 17h. 46m. at the beginning and end of the month respectively. Mars is too close to the sun for favourable observation. Jupiter, in the constellation of Leo, rises at 3h. 48m., 3h. 8m., and 2h. 22m., at the beginning, middle and end of the month respectively. Saturn, in the constellation of Gemini, sets at 14h. 09m., 13h. 16m., and 12h. 13m. at the beginning, middle and end of the month respectively. The Orionid meteors should be seen during October 18–26.

## Announcements

THE Committee of Privy Council for Medical Research has appointed Dr. Alan N. Drury (director of the Lister Institute of Preventive Medicine) and Prof. James C. Spence (professor of child health in the University of Durham and honorary physician to the Royal Victoria Infirmary, Newcastle-upon-Tyne) to be members of the Medical Research Council as from October 1.

THE Royal Aeronautical Society is arranging a discussion on civil aviation to be held on November 4 at the Institution of Mechanical Engineers. The discussion, which will begin at 10.30 a.m. and continue throughout the day, will be divided into sections dealing with economics, aircraft and aero engine design, route facilities (meteorology, radio, aerodromes, etc.) and the selection and training of personnel. The chair will be taken by Lord Brabazon. Tickets of admission will be available only through members of the Royal Aeronautical Society.

ERRATUM. In the communication "Standardization of Root Excretions . . ." by Dr. C. Ellenby in *Nature* of September 16, p. 363, for "a second sample is taken" read "the second oxygen determination is made".

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## The Magnetic Current

IN an article in *Nature* of February 5, 1944, entitled "Magnetic Current", Mr. James T. Kendall deals with movements of dia- or para-magnetic liquids in non-homogeneous magnetic fields, combined with electrodynamic rotations. He states that his horizontal magnetic field is not uniform (non-homogeneous) and observes the mass movement of the liquid as disclosed by refractive index striation without making use of the dark field of a microscope.

I am using vertical magnetic and electric fields of the highest homogeneity, separately and combined, so as to make those fields coincide with the gravitational field[1]. The two vertical cylindrical pole pieces, 6–12 mm. in diameter, have been adjusted so that their opposing circular faces are exactly horizontal and parallel, and the distance separating them can be regulated. In and around the space between these two pole faces (0·5–2 mm. apart) the movement of single microscopic particles in gases or particles and bubbles in liquids can be observed in the dark field of a microscope with low or high aperture. It is self-evident that observation with more sensitive means discloses new facts, permitting measurements of forces down to $8 \times 10^{-11}$ dynes. Those forces are measured by comparing them with the gravitational force exerted upon the single particle[2,12].

The essential facts proving the existence of the magnetic current are the following. (1) Polar movement of single particles to the north or to the south in a homogeneous magnetic field in gases, reversing their direction with the reversal of the field, their velocity depending on the field strength. The Peregrinus experiment of A.D. 1269 leads to a positive result when repeated with sensitive means. The above observation[3] leads to the concept of the magnetic ion, counterpart to the electric ion. Magnetic ions, north or south, can be produced by friction, by chemical means or by irradiation, as it is well known for electric ions. I have observed also magnetophoresis[4], the counterpart to electrophoresis (Reuss, 1809), as well as coagulation of matter in homogeneous magnetic fields.

(2) I have also observed magnetophotophoresis; it is the movement of particles of the same kind and size in and against the direction of the lines of force in the homogeneous magnetic field[5] when irradiated by concentrated light. They reverse with the field, their velocity being a function of the field strength and light intensity. This phenomenon is the counterpart to electrophotophoresis[6].

(3) I have observed magnetolysis of water, which is proved by the appearance of oxygen (up to 12 per cent per volume) if the two ends of one piece of soft Swedish iron immersed in acidulated water (1–4 per cent acid by volume was used) are magnetized north and south. In the blank experiment without magnetic field, pure hydrogen (0·00 per cent oxygen) is evolved[7]. The quantity of gas evolved depends on the field strength. A so-called permanent magnet of Alnico alloy, fitted with pole-pieces of soft Swedish iron, gave the same result, namely, oxygen was found in the gases evolved and more of the latter was found to be coming from the north pole than from the south. The north pole was attacked more strongly than the south pole and in every experiment a larger volume of gas was collected from the north than from the south pole. Chemical analysis of gas was not made in every case. These phenomena prove again that magnetism is polar[8].

(4) The permanent magnets used lost a portion of their pole strength during the magnetolytic processes as determined by search coil and ballistic galvanometer, and were found to be at a steady state before and after the tests. This is the counterpart of the loss in pole-strength of Volta's pile during electrolysis. The loss of pole-strength per second gives the average intensity of the magnetic current flowing between the pole-faces in absolute magnetostatic units. Using the standardization of the International Electrotechnical Commission, Brussels-Scheveningen*, 1936, the intensity of the magnetic current in practical units can be defined as follows:

Pragilbert $\times$ Intensity of Magnetic Current = Watt.

The magnetic currents measured in these practical units have had intensities up to $1 \cdot 7 \times 10^{-10}$.

(5) I have observed an electric vortex (whirl) around the iron wire connecting the two poles of an electromagnet or a so-called permanent magnet in a surrounding liquid bearing electrostatic charges. The same phenomenon occurs if the iron wire is covered by a thin electrically insulating material. This is the counterpart to the magnetic vortex (whirl) around the wire connecting the two poles of Volta's pile (using Oersted's own formulation). Using the dark field of the microscope, I have observed the circulation of a single electric charge, negative or positive, the direction of circulation being opposite in the two cases, this charge being on a bubble in liquid or on a solid particle in liquids or gases in or around the constant vertical homogeneous magnetic field. The intensity of the magnetic current measured electrically is equal to the work done by carrying a unit electric charge once about the entire magnetic current. This electric action of magnetic currents represents the third force in Nature besides the force of gravity and the well-known magnetic action of electric currents (Oersted, Biot-Savart, Lorentz). The use of this third force is *in principio* the magnetic motor[9].

(6) I have also observed that particles can carry simultaneously electric and magnetic charges; this has been concluded from the spiral tracks of bubbles and particles upwards and downwards in the constant vertical homogeneous magnetic field in gases and liquids. Their velocity of motion is of the order of magnitude of $10^{-2}$ cm./sec. in liquids and 1 cm./sec. in gases[10].

(7) It should be mentioned that there exists a polar movement in the geomagnetic field alone simultaneously with the north and south movements of microscopic particles of nickel or iron in gases at atmospheric pressure, when they are irradiated by light. They cease their movement when the magnetic field of the earth is compensated by an opposing field of the same strength and resume this movement if the compensating field is removed[11].

Furthermore, there is no ground for the doubt, raised by Mr. Kendall, about the validity of measurements of smaller charges than the electronic charge. I discovered and published this first in 1910 and finished this work in 1937, showing that on small

* For these data I am obliged to Brother Gabriel Kane, New York City.

spherical bodies of known density there are electrostatic charges smaller than the electronic charge. Using the same method, I found that the numerical value of the magnetic charge on a single particle, for example, of nickel in gas, can also be smaller than $4–5 \times 10^{-10}$ M.S.U.[12].

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[1] Ehrenhaft, F., *Ann. Phys.*, **13**, 160 (1940).

[2] Ehrenhaft, F., *Phys. Rev.*, **63**, 461 (1943).

[3] Ehrenhaft, F., *J. Frank. Inst.*, **233**, 254 (1942); *Phys. Rev.*, **61**, 733 (1942).

[4] Ehrenhaft, F., and Banet, Leo, *Science*, **96**, 228 (1942).

[5] Ehrenhaft, F., *C.R. (Paris)*, **190**, 263 (1930); *Phys. Z.*, **31**, 478 (1930); *Phil. Mag.*, **11**, 140 (1931); *Ann. Phys.*, **13**, 151 (1940); *J. Frank. Inst.*, **230**, 381 (1940); **233**, 235 (1942); *Nature*, **147**, 25 (1941); *Science*, **94**, 232 (1941). Reeger, E., *Z. Phys.*, **71**, 646 (1931).

[6] Ehrenhaft, F., *Phys. Z.*, **31**, 478 (1930). Placzek, G., *Z. Phys.*, **49**, 601 (1928). Selner, P., *Z. Phys.*, **71**, 658 (1931). Lustig, A., and Soellner, A., *Z. Phys.*, **79**, 823 (1932).

[7] Ehrenhaft, F., *Phys. Rev.*, **63**, 216 and 461 (1943).

[8] Ehrenhaft, F., *Phys. Rev.*, May 1 and 15, 1944.

[9] Ehrenhaft, F., *Phys. Rev.*, **63**, 461 (1943); **64**, 43 (1943); and May 1 and 15, 1944.

[10] Ehrenhaft, F., *Phys. Rev.*, **65**, 62 and 256 (1944).

[11] Ehrenhaft, F., *J. Frank. Inst.*, **233**, 240 (1942).

[12] Ehrenhaft, F., *Phys. Z.*, **11**, 619 (1910), etc.; **39**, 673 (1938); *Nature*, **84**, 182 (1910); see also *Phil. Mag.*, **49**, 633 (1925); *Phil. Sci.*, **8**, No. 3 (July 1941).

## Mechanisms for the Relaxation Theory of Viscosity

A RECENT communication by D. D. Eley and D. C. Pepper[1] describes experiments on the plastic flow of plasticized cellulose derivatives. They find that the flow velocity of compression of cylinders and extension of rods depends exponentially on stress at moderate stresses as the simple relaxation theory predicts[2,3], but at higher stresses flow velocity approaches linearity with stress. This behaviour at high stress leads them to question the applicability of the relaxation theory in general to flow problems.

We have observed this same phenomenon in the published data on other disperse systems, such as greases, paints and clay slips. In fact, the phenomenon appears to be characteristic of solid–liquid dispersions the flow of which has in the past been described by the Bingham yield-value equation.

The situation has been explained in the way which we now outline[4]. Consider a system where flow—or place exchange—involves the breaking of at least two types of bonds. Type 1 consists of strong bonds so that they flow according to a non-Newtonian law (at moderate stresses, the exponential law), while Type 2, being weak bonds, obeys the Newtonian law (that is, flow is proportional to stress). The total shear stress, $f$, is expressible as a sum

$$f = f_1 + f_2, \qquad (1)$$

where $f_1$ is the shear stress acting on Type 1 bonds and $f_2$ on Type 2 bonds. Now the rate of shear of each type of bond is given by the hyperbolic-sine law according to the relaxation theory. For the Type 1 (strong) bonds this general law simplifies to the exponential law

$$\frac{ds_1}{dt} = \frac{\lambda}{\lambda_1} k_r \, e^{f_1 \lambda_2 \lambda_3 \lambda / 2kT}, \qquad (2)$$

while for the Type 2 (weak) bonds the general law simplifies to the linear law

$$\frac{ds_2}{dt} = f_2/\eta_2 \qquad (3)$$

Here $\lambda_2\lambda_3$ is the cross-section of the flowing unit on which the shear stress acts; $\lambda_1$ is the distance between neighbouring moving units in the direction normal to shear; $\lambda$ is the distance jumped on each relaxation; $k_r$ is the frequency of the relaxation jump in the direction of flow, at zero stress, and has a well-known form according to the statistical theory of reactions; $\eta_2$ is the viscosity due to the Type 2 bonds, which can also be expressed in terms of the dimensions of the unit of flow and the frequency of the relaxation jump for the Type 2 process[2]; $k$ is the Boltzmann constant; $T$ is the absolute temperature.

Now the condition that the two types of bonds shall yield at the same rate is that the shear-rates be equal:

$$\frac{ds_1}{dt} = \frac{ds_2}{dt} = \frac{ds}{dt} \qquad (4)$$

The relation between total stress and shear-rate is thus

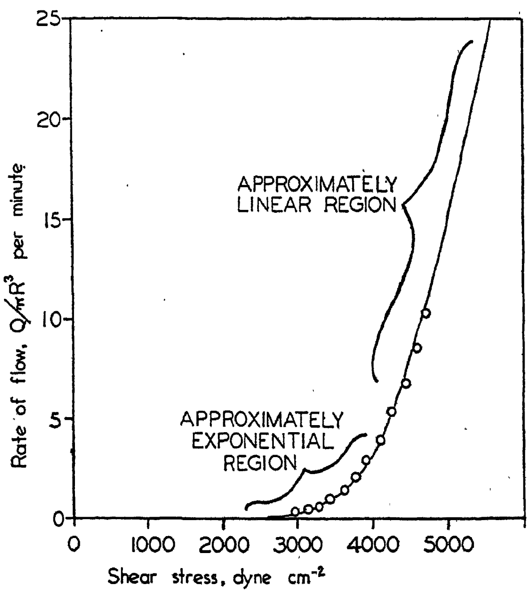
$$f = \eta_2 \frac{ds}{dt} + \frac{kT}{\lambda_2 \lambda_3 \lambda/2} \ln\left(\frac{\lambda_1}{\lambda k_r} \frac{ds}{dt}\right), \qquad (5)$$

which in its simplest form is

$$f = \eta_2 \frac{ds}{dt} + a \log \frac{ds}{dt} + b \qquad (6)$$

In agreement with the results of Eley and Pepper, Eq. (6) gives a shear-rate which depends exponentially on stress at small stresses where the term for breaking of Type 1 bonds predominates, and a shear-rate which depends linearly on the stress at large stresses where the term for breaking of Type 2 bonds predominates. The application of Eq. (6) is illustrated in the accompanying graph, where the equation has been fitted to the data of Blott and Samuel on a lime-base grease[5]. It may be mentioned that the above treatment gives a theoretical explanation not heretofore offered for the curvature always observed at low stresses in 'yield-value' plots.

Two additional tests of the correctness of the present interpretation are available. The first is




THE CIRCLES ARE EXPERIMENTAL DATA FOR A LIME-BASE GREASE STUDIED BY BLOTT AND SAMUEL. THE CONTINUOUS CURVE IS A THEORETICAL CURVE CALCULATED FROM EQUATION 6.

that the slope of the straight-line portion of the curve should correspond to a viscosity which is nearly equal to the viscosity of the Newtonian component of the dispersion. Goodeve and Whitfield have found this to be true for carbon black pastes[6]. The second test is that the temperature coefficient of the flow should indicate an activation energy in the low-stress region typical of the Type 1 bonds, while the activation energy in the high-stress region should have the much lower value typical of the Type 2 bonds. This is confirmed by the reported observations of Eley and Pepper, who find 30 kcal. and 11 kcal. respectively in the two regions.

Thus we conclude not that the relaxation theory of flow treated according to statistical mechanics is in question, but that, given the data on flow of a complex system, one can discover its mechanism.

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Aug. 8.

[1] Eley and Pepper, *Nature*, **154**, 52 (1944).
[2] Eyring, *J. Chem. Phys.*, **4**, 283 (1936).
[3] Tobolsky, Powell and Eyring, "Chemistry of Large Molecules", 125 (Interscience, 1943).
[4] Powell, thesis, Princeton University (1943).
[5] Blott and Samuel, *Ind. Eng. Chem.*, **32**, 68 (1940).
[6] Goodeve and Whitfield, *Trans. Far. Soc.*, **34**, 511 (1937).

Powell and Eyring have shown that the form of the flow/stress relation observed by us may be described by the addition of a second flow-process. Since this second process is postulated to involve weak bonds, it will be Newtonian on their theory.

We would note that the need to assume two types of bond is not so clear for a plasticized polymer as for a solid–liquid dispersion. In fact, Tobolsky and Eyring[1] have considered only one bond, of the strong type, in the flow of plastics, and have derived a theory of extrusion on this basis. Some point may be added to this objection by the observation that the test of Powell and Eyring, that the limiting viscosity of the system should nearly equal the viscosity of the Newtonian component (that is, plasticizer), fails when applied to our system. The former is $10^8$ poises, while the latter is 0·2 poises.

Powell and Eyring quote experiments on solid–liquid dispersions. It seems a somewhat lengthy extension of the theory of relaxation, to apply it to the forces between macroscopic solid particles. However, assuming this to be correct, their theory implies that as the stress is increased, the flow should first be exponential, then Newtonian, and *then once again exponential*, the last effect occurring when the stress $f_2$ on the weak bonds reaches values where $f_2\lambda_2\lambda_3 \gg 2kT$. This last effect has never been observed, but it would offer a possible test of their theory.

We would not claim that the above remarks definitely rule out some form of two-bond mechanism for our system, but we would submit that there is a case for examining all possible 'one-bond mechanisms'. The general notion of a potential barrier may be taken as essential to any theory of flow in plastics, but the specific features of Eyring's theory, such as the hyperbolic sine law for stress, have never been properly established. For example, a test of this law carried out by Tobolsky and Eyring on creep and stress relaxation in rubber and steel[2] was successful only up to a point, in that the viscous volume parameter, $\lambda_1 \lambda_2 \lambda_3$, was found to depend upon initial stress. The position cannot be clarified until a larger body of evidence is available on the flow of plastics and liquids, including especially Newtonian liquids, over the widest possible ranges of stress and temperature.

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[1] Tobolsky and Eyring, *J. Chem. Phys.*, **11**, 131 (1943).
[2] Tobolsky and Eyring, *J. Chem. Phys.*, **11**, 128 (1943).

## Formation of Apatite from Superphosphate in the Soil

THE bulk of the phosphate added to soils as fertilizer remains in forms unavailable to plants. In calcareous soils it has been said to form hydroxyapatite. From a study of the reversion of mixtures of superphosphate and liming materials, MacIntire and his associates[1] have recently suggested that the ultimate form of some of the phosphate applied to heavily limed soils may be fluorapatite; but, so far as we have been able to ascertain, no direct evidence has ever been obtained of the actual presence in the soil of apatite formed from fertilizers.

The Broadbalk continuous wheat plots at Rothamsted provide favourable conditions for studying this question. Superphosphate has been applied to some of the plots annually for nearly a century, and the whole field had been heavily dressed with local chalk some decades before the experiments commenced. Since it appeared likely that the phosphate would accumulate in or around the soft porous chalk particles, these were isolated from samples of two plots taken in the spring of 1944. Such fragments (0·5–2 mm. diameter) from the plot (No. 5) with superphosphate but no nitrogenous fertilizer contained about 3 per cent $P_2O_5$, which is ten times as much as on the plot (No. 3) without fertilizer. On heating the chalk from plot 5 to 800° and extracting with carbon dioxide-free sucrose solution to remove calcium oxide, a residue was left which gave the X-ray powder diagram of apatite. A partial analysis of a 140 mgm. sample of the residue gave 47 per cent CaO, 26 per cent $P_2O_5$, 1·5 per cent F and 10 per cent insoluble in hydrochloric acid. (Some fluorine was lost during the ignition.) The refractive index was $n_D$ 1·601. Efforts to isolate the phosphate from the chalk without heating have not yet been successful, but X-ray diffraction data suggest that apatite is present.

Further analyses showed that where superphosphate had been applied, the phosphate content increased rapidly with decreasing grain size of the chalk fragments. The values for individual grains were highly variable, but consistent results were obtained by separating the whole of a given fraction from a bulk soil sample.

$P_2O_5$ PERCENTAGE OF CHALK FRAGMENTS FROM BROADBALK SURFACE SOIL (SECTION 4), 1944.

| | Plot 5 | Plot 3 |
|---|---|---|
| Mean values in whole fraction from 500 gm. soil | | |
| 0·5–2 mm. | 2·8 | 0·33 |
| 2–5 mm. | 2·0 | — |
| Individual grains 3–7 mm. | | |
| Mean | 1·4 | 0·13 |
| Extremes | 0·09–5·5 | 0·045–0·23 |

Analyses of chalk fragments from Plot 5 (0·5–2 mm. diameter, isolated from 100 gm. soil sampled in 1865 and from 500 gm. from later samples) showed that the phosphate and fluorine contents increased gradually with time, and at an increased rate from about 1888 onwards. From 1852 until 1888 the superphosphate had been made from bone ash, which contains little fluorine; afterwards mineral phosphate was used and considerable amounts of fluorine would therefore be added annually.

$P_2O_5$ AND F PERCENTAGES IN CHALK FRAGMENTS FROM BROADBALK SURFACE SOILS.

| | | % $P_2O_5$ | % F |
|---|---|---|---|
| Plot 5 | | | |
| | 1865 | 0·28 | n.d. |
| | 1881 | 0·44 | 0·032 |
| | 1893 | 0·80 | 0·045 |
| | 1901 | 1·15 | 0·078 |
| | 1914 | 1·7 | 0·11 |
| | 1944 (section 4) | 2·8 | 0.25 |
| Plot 3 | | | |
| | 1881 | 0·13 | 0·032 |
| | 1944 (section 4) | 0·33 | n.d. |

Throughout the experiment the plots have steadily lost calcium carbonate by leaching[2]. This may account in part for the increase in $P_2O_5$ percentage in the chalk fraction of the unmanured plot, but it can only be a secondary factor in the accumulation of phosphate in the chalk from Plot 5.

Further work is in progress on the formation of apatite in soils and its relation to phosphate fixation.

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[1] MacIntire, W. H., and Hatcher, B. W., *Soil Science*, **53**, 43 (1942).
[2] Hall, A. D., and Miller, N. H. J., *Proc. Roy. Soc.*, B, **77**, 1 (1905).

## Heredity, Development and Infection

DR. DARLINGTON'S[1] interesting article on "Heredity, Development and Infection" calls for two comments. He states that the "molecular system" of heredity, consisting of plasmagenes, "has been hitherto supposed to be purely maternal in inheritance". There is at least one case to the contrary in animal genetics. L'Héritier and Teissier[2] found that the character of susceptibility to carbon dioxide in *Drosophila melanogaster* was transmitted to all the progeny of a susceptible mother, but to a fraction only of those of a susceptible father. Kalmus[3] found that the same was true in an interspecific cross.

Dr. Darlington later cites Crane and Lawrence's[4] conclusion that roses may revert from the climber to the bush type as the result of bud-grafting on to a dwarf stock. He regards the agent transmitted as a plasmagene rather than a virus, since the bushy habit of growth in roses cannot be considered pathological. He later adds that "The high frequency of plasmagene and virus mutations, aggravated by the rapidity of their selection, both under nuclear control, gives an almost Lamarckian colour to their adaptation".

Lysenko and his colleagues in the U.S.S.R. have reported a large number of cases in which characters have been transmitted from one plant variety to another by grafting. They have been accused of Lamarckism, among other things. It would seem that British plant geneticists are now discovering similar phenomena. It may be that Lysenko, with the enthusiasm of a pioneer, has criticized Mendelian conceptions unjustifiably, as the biometric school did in Great Britain. But this is scarcely a sufficient reason for ignoring his work, particularly as some of his publications antedate that cited by Dr. Darlington. I yield to no one in my admiration of the work of the American drosophilists on nuclear genetics, which I supported in Great Britain when the chromosomal theory of inheritance was unfashionable. But perhaps we can also learn from our other allies.

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Aug. 25.

[1] *Nature*, **154**, 164 (1944).
[2] *C.R. Acad. Sci. Paris*, **205**, 1099 (1937); **206**, 1193, 1683 (1938).
[3] *Nature*, **152**, 692 (1943).
[4] "Genetics of Garden Plants", 2nd ed. (London, 1937).

## Pressor Effects of Amidine Derivatives

MANY compounds of general formula $R.X.C(:NH)NH_2$—where $R$ is an alkyl group attached to the amidine portion of the molecule either directly ('amidines') or through a divalent radical, $X$, which may be an oxygen atom (*iso*-ureas), a sulphur atom (*iso*-thioureas) or an imino-group (guanidines)—have in common a number of distinctive pharmacological properties[1-4]. Thus representative members of each series have been shown to raise the blood pressure of anæsthetized animals and to enhance the pressor effect of adrenaline by mechanisms which are either partly or wholly peripheral. The increase in tonus produced in different smooth muscle preparations is probably the result of a direct action on the muscle itself[2,3,4].

These investigations have since been extended. Preliminary tests were carried out with some two hundred compounds, the following effects, which were recorded as in previous studies, being looked for particularly as criteria of activity: elevation of the blood pressure in dogs and cats anæsthetized with sodium barbitone, increased pulmonary ventilation and an enhanced response to adrenaline. The evidence obtained strongly suggests that, whereas such activity is fairly widely distributed among amidine derivatives, it is inconspicuous, if present at all, in most related substances. Thus it was not apparent in imino-ethers or in ureas, thioureas, thiohydantoins, carbamates, thiocarbamates and similar compounds which have an amide or thioamide but not the structurally similar amidine group.

In the *iso*-thiourea series, where the relationship between structure and activity was studied especially, it was found that a variety of substituents could be introduced into the molecule without pressor activity necessarily being lost, salts of (2-methyl-)allyl *iso*-thiourea, (3-hydroxy-)*n*-propyl *iso*-thiourea, methoxymethyl *iso*-thiourea (I), (2-phenyl-)ethyl *iso*-thiourea, ethylene *iso*-thiourea (II), methyl N, N'-diphenyl *iso*-thiourea (III), and numerous similar derivatives all raising the blood pressure in doses of 1–10 mgm./kgm. Pressor activity was most evident in the lower homologues of methyl *iso*-thiourea but, unlike methylene di-*iso*-thiourea (IV), formamidine disulphide (V) had little effect on the blood pressure. A few related compounds (for example, hexamethylene

(I) $CH_3.O.CH_2.S.C(:NH)NH_2$

(II) $H_2C.S.C:NH$
$\quad | \quad |$
$H_2C$—NH

(III) $CH_3.S.C(:NC_6H_5)NHC_6H_5$

(IV) $H_2N(HN:)C.S.CH_2.S.C(:NH)NH_2$

(V) $H_2N(HN:)C.S—S.C(:NH)NH_2$

(VI) $H_2C.S.C:NH$
$\quad | \quad |$
O:C—NH

di-*iso*-thiourea) produced sustained falls. Derivatives with substituents in the amidine part of the molecule (for example, II and III) may cause well-defined pressor effects but, as a rule, activity is reduced or even abolished by this procedure. More examples of *iso*-thioureas displaying little activity were found in compounds like the hydrochlorides of acetyl and carbomethoxy *iso*-thioureas (which do not keep well *in vitro*) and *iso*-thiohydantoin (VI). Fewer amidine derivatives belonging to other series (guanidines, amidines, *iso*-ureas) were examined, but the results obtained indicate that the pressor activity of lower members is influenced by structural changes in much the same way as that of the corresponding *iso*-thioureas.

Many of the compounds altered the sensitivity of the preparation to the pressor action of adrenaline. The response to the latter was increased especially, but by no means invariably, by those pressor amidines which showed tachyphylaxis to a considerable extent. A decrease in sensitivity was also noticed sometimes, compounds such as carbomethoxy and benzyl *iso*-thiourea hydrochlorides often having adrenalytic effects in cats. These two salts, unlike most others, normally increased the pulse-rate.

Although the fifty-odd amidine derivatives which were shown to be pressor differ to a remarkable extent from the point of view of chemical constitution, they resemble one another more closely in the possession of certain physical properties. Measurements of the ionization constants of the parent bases show that the majority at least are strong electrolytes. The values obtained or found recorded for such *iso*-ureas and *iso*-thioureas ($pK_a \simeq 9$–$11$) are less than those for the corresponding amidines ($pK_a \simeq 12$) and guanidines ($pK_a \simeq 12$–$14$), but are still sufficiently high[5] to allow for 99–100 per cent ionization in water, if not in blood, at $p$H 7·3. No examples have been found as yet of weak amidine bases the salts of which are strongly pressor. On the other hand, some of the amidine derivatives which have little effect on the blood pressure were shown to be extensively hydrolysed in solution ($pK_a \simeq 7$ or less) and so should provide a smaller concentration of amidine cations than their more active relatives under the same conditions. Other strong organic bases (for example, ethylamine, tetramethylammonium, acetylcholine) may differ widely in their circulatory effects from typical amidine derivatives; possibly the basicity is of importance in so far as it determines access to the effectors[6]. In this connexion it is of interest that the pressor activity of amidine derivatives (but not apparently some of their other properties[7,8,9]) seems to be affected adversely by an increase in the length of sidechains even though the basic ionization constant may be unaltered or actually increased at the same time. The possibility that amidine cations alter the properties of cells through successful competition with inorganic cations of physiological importance has not been overlooked.

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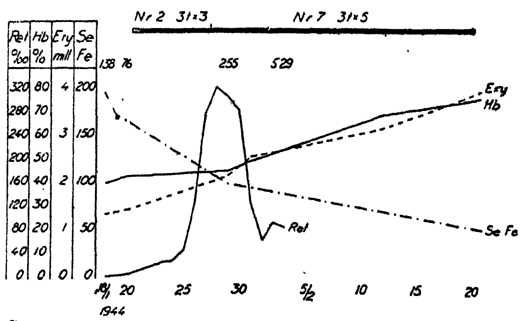
[1] McGeorge, M., Sherif, M., and Smirk, F. H., *J. Physiol.*, **100**, 474 (1942).
[2] Fastier, F. N., and Smirk, F. H., *J. Physiol.*, **101**, 379 (1943).
[3] Fastier, F. N., Smirk, F. H., and Strang, D. U., in the press.
[4] Crawford, R., Fastier, F. N., and Smirk, F. H., in the press.
[5] Albert, A., *Aust. J. Science*, **6**, 137 (1944).
[6] Bourne, G., "Cytology and Cell Physiology" (Oxford, 1942), 91.
[7] Broom, W. A., *J. Pharmacol.*, **57**, 81 (1936).
[8] Dickens, F., *Biochem. J.*, **33**, 2017 (1939).
[9] Fuller, A. T., *Biochem. J.*, **36**, 548 (1942).

## Nature of the Anti-anæmic Factor (Castle)

IN a series of papers I have advanced the theory that the intrinsic factor of Castle might be identical with the enzyme aminopolypeptidase[1,2,3]. In brief, the experiments reported in these papers demonstrated that intravenous injections of crystalline secretin provoked in cats a secretion from the mucous membrane of the distal part of the pyloric and the proximal part of the duodenal region, the part of the alimentary canal from which the intrinsic factor is considered to be secreted[4,5]. The secretion contained a rather high concentration of aminopolypeptidase. In accordance with the results obtained by Castle, it was demonstrated that an enzymatic reaction (proteolysis) took place after incubating the secretion with a muscle extract. When preparing the enzyme from the hogs' pyloric mucosa, it was found that purified enzyme solutions apparently contained most of the intrinsic factor activity present in the mucous membrane. The intrinsic factor activity was estimated by allowing the purified enzyme solution to react with liver according to the methods outlined by Reimann[6] and Sjögren[7]. At this stage of the investigation (1941) the aminopolypeptidase had been purified about ten times. Since then, the enzyme has been further purified, in all about a hundred times.

The intrinsic factor activity of this purified enzyme has now been tested. The method of purifying will be published elsewhere. The estimation of the intrinsic factor activity of the purified aminopolypeptidase solution was based on the following experimental results. The concentration of aminopolypeptidase in the fresh pyloric mucosa was determined. Then it was easy to calculate the amount of enzyme activity present in the sample of pyloric mucosa used by Sjögren as intrinsic factor material. The next step was the determination of the aminopolypeptidase activity of vacuum-dried pyloric mucosa. This was the material from which the enzyme of the present investigation was prepared. It was found that half the original aminopolypeptidase activity was left after the desiccating process. As 1 gm. of the dried material corresponded to 6 gm. of fresh material, it was easy to calculate how much of the purified enzyme would be used in the activating experiment.

In the course of this, the aminopolypeptidase from 10 kgm. of vacuum-dried pyloric mucosa was purified a hundred times. As the yield by the method of preparation used was 25 per cent, the amount of aminopolypeptidase activity in the solution of the one hundred times purified enzyme was the same as in




GRAPH SHOWING RESPONSE IN A CASE OF PERNICIOUS ANÆMIA TO ORAL TREATMENT WITH LIVER PREPARATION Nos. 2 AND 1 ACTIVATED WITH ONE HUNDRED TIMES PURIFIED AMINOPOLYPEPTIDASE.

7·5 kgm. of fresh pyloric mucosa. The solution was halved (dry weight of each was 10·5 gm.). One half of the solution was substituted for the intrinsic factor activity of 3·7 kgm. of fresh pyloric mucosa in the activation of raw liver. This preparation was called No. 2. In preparation No. 1 the other half of the enzyme solution was substituted for the intrinsic factor activity of 7·5 kgm. of fresh pyloric mucosa. It was assumed that if the intrinsic factor activity had really been purified parallel with the aminopolypeptidase activity, then it should be possible to trace the activating effect of half the optimal dose of intrinsic factor on liver. The daily therapeutic dose of preparations 1 and 2 contained material from about 30 gm. of fresh activated liver, and were given orally to the patients in the form of 3 × 5 tablets. The preparations were tested with positive results on four patients with pernicious anæmia. The results of the treatment are demonstrated in the accompanying graph, which shows that both preparations, Nos. 1 and 2, are active. The clinical results, therefore, seem to favour the assumption that aminopolypeptidase may be identical with the instrinsic factor. A detailed report will be published elsewhere[8].

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[1] Ågren, G., *Enzymologia*, 10, 161 (1942).
[2] Ågren, G., *Arkiv Kemi, Mineralogi, Geologi*, 16 B, No. 6 (1942).
[3] Ågren, G., *Arkiv Kemi, Mineralogi, Geologi*, 17 B, No. 16 (1943).
[4] Meulengracht, E., *Acta Med. Scand.*, 82, 226 (1934).
[5] Wallgren, I., *Nord. Med. Tidskr.*, 20, 2061 (1943).
[6] Reimann, B., *Med. Klin.*, 27, 880 (1931).
[7] Sjögren, B., *Acta Med. Scand.*, 106, 479 (1941).
[8] Ågren, G., and Waldenström, J., *Acta Med. Scand.* (in the Press).

## Variation of Ascorbic Acid in Tomatoes

IN view of the wide differences of ascorbic acid content within various types of fruit and vegetables reported in the literature, we have recently carried out a study of some of the sources of variation in the tomato.

Our figures suggest that the sample size should be at least sixteen separate fruit taken at random from the batch or plot for any intervarietal differences to be significant, and this would indicate that many of the results quoted in the literature show divergences for this reason.

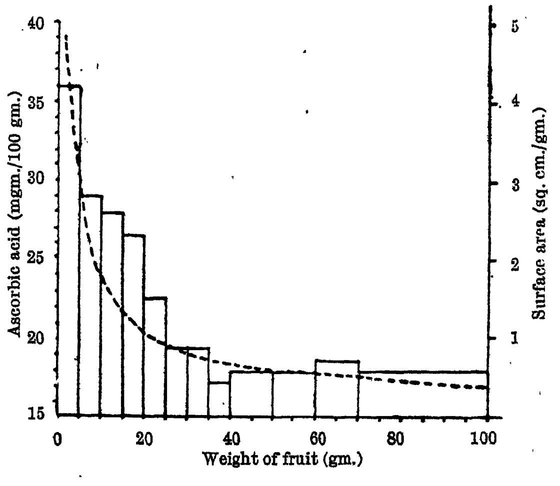
The fruits of any one variety may show wide variations, however.

We find that the ascorbic acid content of the fruits of one bush, although showing considerable constancy in all the fruit ripe at any one time, tends to increase as the plant ages. This was found to hold whether the fruits were collected from plants grown either during the spring when the days were lengthening, or during the autumn, when they were shortening.

We have also found a very marked bush-to-bush variation. The difference between the highest and lowest ascorbic acid contents found in the fruits of any one variety grown in one plot were of the order of 100 per cent (24–51 mgm./100 gm.). This is considerably greater than the variation between the mean ascorbic contents of the different varieties grown. By growing plants from the seed taken from tested tomato plants, we found that this plant-to-plant variation tends to persist in the crop of the following year. Selection in this manner seems to offer some prospect of building strains of any variety which would be high in ascorbic acid content and yet still possess desirable market qualities.

Most striking of all, however, has been the finding that the ascorbic acid content is closely related to the size of the fruit within certain size limits, as can be seen from the graph. The histogram of weight against ascorbic acid suggested that the tomatoes might be divided into two groups, separated at 30 gm. weight. Analysis of these figures showed that the fruit of less than 30 gm. weight gave a correlation coefficient of $-0·94$, highly significant at the 1 per cent level for the effect of weight on ascorbic acid. Those fruit of 30 gm. and more, on the other hand, gave a non-significant coefficient of $-0·03$.

All the fruit came from six bushes of one variety from which every fruit was collected and analysed. On the admittedly crude assumption that the fruit was spherical, the relationship between weight and surface area was worked out, and is represented by the accompanying curve. The close similarity between this curve and the histogram is obvious. As the weight increases there is a rapid decline in the surface area/weight ratio in the small fruit; but as the fruit becomes heavier, the decrease becomes less and less marked. If we make the assumption that the ascorbic acid is to a large extent synthesized in the fruit, by the effects of light rays, then the content of ascorbic acid present would vary with the amount of light energy received per unit weight of fruit. On this hypothesis, the wide surface area/weight ratio of the smaller tomatoes would be responsible for their higher ascorbic acid content, since for these the



ratio of light energy received to the weight of the fruit would be greatest.

The universality of this relationship even in tomatoes remains yet to be worked out, but these results at least cast some doubt on the value of the suggested use of *Lycopersicon pimpinellifolium*, which bears very small fruits, in a tomato breeding programme designed to produce fruits of a high ascorbic acid content[1].

Examination of other data available in the literature in the terms of this hypothesis may be fruitful. For example, a varying surface area/weight relationship may be partly responsible for the variation in ascorbic acid content of different species of Rosa previously attributed to genetical influences[2]. The increase in the ascorbic acid content in the tetraploid as compared with the diploid cabbage reported by Barr and Newcomer[3] is accompanied by a decline in weight. The same factors may be operating here.

The results will be published in detail elsewhere.

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[1] Lyon, C. B., Beeson, K. C., and Ellis, G. H., *Bot. Gaz.*, **104**, 495 (1943).
[2] Darlington, C. D., *Nature*, **150**, 404 (1942).
[3] Barr, C. G., and Newcomer, E. H., *J. Agric. Res.*, **67**, 329 (1943).

## The Laws of Nature

PROF. H. DINGLE's very interesting article[1] has laid bare in the clearest and most unambiguous terms the dubious validity, not so much of the distinction which the formulæ incidental to the historical development of science have imposed on our fundamental conceptions, resulting in an apparent deep-rooted contradiction between the equations representing the reaction of matter towards motion and temperature, but of an extension of the special theory of relativity which at present appears to pass without comment or challenge. It is usual to assume—and Einstein has himself lent authority to the assumption—that because the relativistic form of the equations of motion (apparently) for ever bar any measurement of absolute velocity relative to the framework of the universe, therefore absolute velocity with respect to any such framework does not exist; and, as a further extension, that it is trivial and useless to inquire what may be the quality of that framework, and whether or not there may be a luminiferous ether.

Prof. Dingle has shown that it is not difficult to conceive a relativistic statement of the laws governing temperature, relegating radiation to much the same position as the ether enjoys in the special theory of relativity. But if such a formulation were successfully accomplished, would we on that account be tempted to deny the existence of radiation? No, for we cannot escape its obvious effects. Let us now go one step further. Fifty years ago, an eminent school of thought attempted to replace atomistics by energetics; and had the work of the physicists which culminated in the discovery of radioactivity and the quantum been delayed another fifty years, science might well to-day have promulgated a dogma according to which it was trivial and useless to inquire whether atoms did or did not exist, and averring that their existence was after all improbable.

I do not for one moment wish to call into question the validity of the equations on which the special theory of relativity rests; their basis appears as reasonably assured as any of the fundamental bases on which science rests to-day, and all purely mechanical theories of the ether seem discredited. But it does appear somewhat incautious to assume that no subsequent developments will ever point to the probability of some spatio-temporal particularization of the framework of the universe and the existence of absolute motion with reference to it, even if the laws governing the measurement of all motion preclude us from measuring such absolute motion directly, leaving us only the possibility of inferring its existence from some otherwise inexplicable phenomenon. Lorentz's contracting electron is only one of a series of mechanisms whereby the impossibility of the measurement of absolute motion can be explained; and it appears invidious to argue about the philosophical probability or improbability of what is, after all, as yet only incompletely understood.

Incidentally, Prof. Dingle states that "a measurement of velocity in terms of the Doppler effect would have given us a finite limit in one direction and an infinite one in the other". This statement, while in no way invalidating the fundamental concepts on which the article is based (measurement in terms of the Doppler effect is primarily cited as a striking example of a measure of velocity invariant with respect to time), seems somewhat strange in an article of which the essence is a plea for "thermal relativity", inasmuch as the relativistic form of the Doppler equation gives an infinite limit for both approach and recession.

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[1] *Nature*, **153**, 736, 758 (1944).

MR. JESSUP's letter raises what, I think, is a fundamental point concerning the significance of relativity theory. In adopting that theory, we do not assume that "no subsequent developments will ever point to the probability of some spatio-temporal particularization of the framework of the universe". We simply regard scientific theory as a description of the world apprehended by experience (more exactly, the correlation of experiences themselves), and require that it shall not include features for which experience offers no evidence. For that reason we regard a theory which includes the existence of absolute velocity as invalid. If future experience should enable us to detect absolute velocity, or even "leave us only the possibility of inferring its existence from some otherwise inexplicable phenomenon", the situation would be altered, and the same principle would then require us to include it in our description. In brief, scientific theory should be, so far as possible, conterminous with experience.

Mr. Jessup's statement that we cannot deny the existence of radiation because we cannot escape its obvious effects is somewhat ambiguous. We cannot escape certain phenomena, but the point is whether they are to be described as effects of radiation. If by radiation we mean something issuing from a body at temperature $\theta$, and proportional in magnitude to $\theta^4$ irrespective of the temperature of the surroundings (as is implied in the generally adopted theory of exchanges), then the above-mentioned principle requires us to deny it. All that we have been able to observe are effects depending on $a(\theta^4-\theta_0^4)$, where

$\theta_0$ is the temperature of the surroundings, and $a$ is a constant. The "obvious effects" are effects of *relative* radiation, just as obvious mechanical effects are effects of relative velocity. $\theta^4$ is (so far) unobservable *absolute* radiation, and is analogous to (so far) unobservable absolute velocity.

The relativistic form of the Doppler equation gives limiting velocities of $\pm c$. It must do this because it is made to conform with a definition of velocity (namely, $ds/dt$) which demands those limits. When I spoke of "a measurement of velocity in terms of the Doppler effect" I was imagining a *definition* of velocity measurement in terms of the relative change of wave-length. This would, of course, not lead to the ordinary relativistic equation, but to $d\lambda/\lambda = v/c$, where $c$ is a constant. Such a definition would, fundamentally, be as legitimate as the canonical one, and would enable us to describe the same phenomena, but the description would, of course, be different.

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Aug. 23.

## A Solar Halo Phenomenon

A PHENOMENON which I have not seen described before occurred in a part of the horizontal ring of a solar halo on August 9, 1944. It consisted of dark bands moving like waves through the very bright ring. The sky was very clear at Cambridge on the morning of that day when a cloud trail was formed by an aeroplane. The trail moved from north-west in an easterly direction. At 11.20 a.m. a section of the horizontal mock sun ring appeared in that part of the cloud which in the north-east had the same altitude as the sun. As the cloud moved on, being steadily deformed and taking the shape of the letter *S*, the halo shifted slowly from left to right.

About a minute later, I noticed dark bands crossing quickly through the brightness of the halo. They were of various grades of darkness and could not be seen continuously. Each band was about $\frac{1}{5}°$ in width and seemed to be perfectly straight. The distance between two adjacent bands was approximately $\frac{1}{2}$–1°. The middle one of a batch of bands was usually the darkest, the brightness of the brilliant mock sun ring being reduced by more than 75 per cent, while the accompanying bands were less dark. The best description of the phenomenon I can give is by comparing it with the rippling of the smooth surface of a lake by an occasional breeze. The bands moved from right to left and their speed seemed very high, approximately 5° per second, that is, very much faster than that of any cloud seen in the sky on that day. They gave the impression of being lower than the halo.

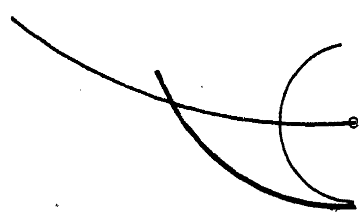
I called a second observer who independently noticed the phenomenon after I had directed his attention to the spot. A description was given in the words: "It is as if the ether waves have become visible".

At 11.25 a brilliant mock sun appeared on the right of the sun. The 22° halo developed and at 11.30 a mock sun could be seen on the left. However, no dark bands were visible in them. Later, a part of the horizontal ring appeared in another cloud trail at 11.45 a.m. The bright patch was this time in the north-west. First one dark band moved quickly through the patch in a northerly direction, taking about $\frac{1}{2}$ sec. to cross it. A few seconds later a whole batch of waves followed, going in a slightly different direction. Then lower clouds covered this part of the sky.

In attempting an explanation of the phenomenon three points will have to be kept in mind. First, the mock sun ring is a halo of the reflexion type produced by ice crystals the side faces of which are orientated in vertical planes and act as mirrors. A slight variation in the direction of the axes of the crystals has a marked effect on the appearance of the halo. I have seen fluctuations of brightness in another reflexion type halo before, namely, in the pillar above and below the sun, but the phenomenon described above is quite different. Secondly, the artificial cloud was less thick than a natural one. A high percentage of the ice crystals situated in the line of sight could therefore be affected simultaneously. Thirdly, different wind directions at various heights at the time of observation were revealed by clouds. Directions noted were north-west, north-east and south-west at ground-level. The deformation of the originally straight aeroplane trail to an *S*-shaped figure proves that the cloud was at a height where two different air currents came into contact. A disturbance may have been caused at the surface of contact, thereby affecting the orientation of the axes of the ice crystals. The swinging of the crystals about their position of equilibrium may have produced the observed optical effect.

G. H. ARCHENHOLD.
c/o Solar Physics Observatory,
Cambridge.

ON August 9, at 0900 G.M.T., numerous aeroplane vapour trails had spread out into wide belts of apparently cirrus cloud. Two mock suns were then visible, one at about 22° from the sun and one nearly opposite to it and at about the same height above the horizon as the sun. These mock suns disappeared after a few minutes.



At 10.30 G.M.T. portions of three halos appeared in the artificial cirrus. The first was probably the 22° halo, the second a concave arc of contact with it, and the third an arc of much greater radius which passed through the sun.

In the case of the two smaller halos the red colour was on the inside. The arc passing through the sun was colourless. The halos were very transient and I had no time to photograph them or to take angular measurements.

The accompanying diagram illustrates the approximate arrangement of the halos.

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Godalming,
Surrey.

THE communication from Mr. C. J. P. Cave[1] prompts me to record a somewhat similar experience. At 7.30 p.m. G.M.T. on the evening of August 3, the sky was clear except for a patch of striated cirrus cloud high up in the sky in a north-westerly direction. There suddenly appeared a band of colours right across this patch as if it were a rainbow. As the sun sank towards the horizon the band of colour moved downwards across the cloud, with an increase in the intensity of the colours. At one time part of a 'secondary' band of colour was visible, but this quickly faded as the band approached the lower edge of the cloud patch. The whole phenomenon lasted approximately fifteen minutes or so.

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Sept. 8.

[1] *Nature*, **154**, 240 (1944).

## Spectrum Formed on a Cloud

BETWEEN 8.55 and 9.00 p.m. British Summer Time on the evening of July 31, my family and I happened to be in our garden looking *towards* the setting sun. The sky was blue, broken by a few wisps of feathery cloud. When two wisps passed in turn at an elevation of roughly 60–70° between us and the sun, each showed a brilliant spectrum. The colours violet, blue, green, yellow, orange and red were clearly seen, violet being on top and red below.

The colours were much more brilliant than in any rainbow we have ever seen; they were evidently projected upon the clouds and the spectrum was therefore real and not virtual. There was no sign of rain at the time and the sun was a bright red ball, hidden from us by trees.

A spectrum such as above described may not be uncommon, but none of us has observed one before.

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## Smoke and Rain

IN a letter in *Nature* of August 12 (p. 213), Dr. J. R. Ashworth directs attention to the fact that the average rainfall at Rochdale on Sundays was 6 per cent below the average for weekdays during the thirty years 1898–1928, and that a similar deficit is evident if the data for the forty-five years 1898–1943 are used. It would have been interesting if he had quoted separately the figures for the latest fifteen years, 1929–43.

The average annual rainfall for each day of the week during 1929–43 can be deduced from the figures quoted in Dr. Ashworth's letter, and appear to be as follows:

| Sun. | Mon. | Tues. | Wed. | Thurs. | Fri. | Sat. |
|---|---|---|---|---|---|---|
| 5·69 | 5·56 | 5·54 | 6·37 | 5·90 | 6·21 | 6·42 in. |

The rather large variations between different days suggest that a period of fifteen years is too short to eliminate the effect of random fluctuations in the rainfall. Nevertheless, the fact that Sunday is only the third driest day suggests that the factors which previously caused Sunday to have the lowest rainfall have now ceased to operate.

Assuming that rainfall is increased by smoke in the atmosphere, the explanation is probably as follows: First, as Dr. Ashworth suggests, the increasing use of electric power has decreased the output of smoke from factories. Secondly, this has probably been accompanied by an increased number of private houses heated by coal fires, which are lit on Sundays as well as weekdays. It therefore seems likely that smoke from domestic coal fires is now a major factor in polluting the atmosphere of urban areas.

J. R. BIBBY.

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Carnforth, Lancs.

## Books: The Warehouse of Knowledge

I HAVE read with interest and appreciation your leading article "Books: The Warehouse of Knowledge" in *Nature* of September 9, 1944. That article is supported by "A Reading Survey" issued by the City of Leeds Public Libraries, and a corresponding survey in technical or scientific libraries might provide even more emphatic support. There are, however, two further points which I think should be borne in mind.

(1) Not only are books of importance for general education and technical training, but also the provision of adequate text-books and monographs on special subjects is of vital importance in research.

(2) Very few technical and scientific books of this class are now being published in Great Britain. The reasons for this are fairly clear from this leading article. The seriousness of this situation is not, however, sufficiently realized. Before the War any shortcomings in the British supply of books could be rectified by the supply of German and other European books as well as American books. The supply of such books has now been reduced to almost negligible proportions under the Trading with the Enemy Regulations, and it now appears that increasing difficulties are being experienced, owing to Government regulations, in obtaining from America the supplies of scientific and technical books which our research workers require for day-to-day purposes. The Government policy with regard to paper control is only part and parcel of a policy and attitude to technical and scientific books which tends to frustrate the effect of proposals for the expansion and development of research.

R. BRIGHTMAN.

Hexagon House, Blackley,
Manchester. Sept. 13.

## Importance of Film Records

REFERRING to Dr. M. Michaelis' communication in *Nature* of September 16, p. 365, I am, of course, well aware of the activities of the newly formed Scientific Film Association. Like the British Film Institute, however, it can only make contact with central organizations. These may or may not know what films are in existence on their particular subject.

Most scientific workers read *Nature*. It is to the individual maker of films that I appeal, in the hope that the learned societies may thus be persuaded to take action. Spreading the burden is preferable to allowing it to fall on the shoulders of any one organization, whose judgment as to what is and what is not worthy of preservation cannot be so authoritative as that of workers in the same field.

OLIVER BELL.

# RESEARCH ITEMS

## Columbia River Salmon

THE *Stanford Ichthyological Bulletin* (2, No. 6; Dec. 1943), published by the Natural History Museum of Stanford University, contains a paper by John C. Marr on "Age, Length, and Weight Studies of Three Species of Columbia River Salmon (*Onchorhynchus keta*, *O. gorbuscha* and *O. kisutch*)", being Contrib. No. 9, Department of Research, Fish Commission of Oregon. The salmon runs of the Columbia River have held an important place in the economic structure of Oregon and Washington since the beginning of their exploitation in the 1860's. The fishing intensity has increased constantly and the reduction of spawning areas, brought about by the construction of dams and other developments of water resources, have acted unfavourably to modify natural conditions and the productivity of the fisheries. In the genus Onchorhynchus the most important commercially is the chinook salmon *O. tschawytscha*; the next in importance are the steelhead *Salmo gairdneri*, the blueback *Onchorhynchus nerka*, the silver salmon *O. kisutch* and the chum *O. keta*, while the pink salmon *O. garbuscha* is not sufficiently numerous to be of commercial importance. As the runs of the chinook and blueback which ascend to the higher reaches of the river system are seriously depleted, the trend of the catch of silvers and chums has been upward in recent years due to an increased fishing intensity. Since they spawn in the lower tributaries they have suffered relatively less from the destruction of spawning beds. Thus they will probably become increasingly important in the commercial fishery, and their life-histories are now being thoroughly investigated. The present work deals in detail mainly with the age, length and weight of *Onchorhynchus keta* and *O. kisutch*. It is demonstrated that, in comparison with data from other localities, in both from south to north there is a decrease in mean length at the same age; older fish are progressively more abundant and the runs are progressively earlier.

## An Interesting Larval Trematode

R. M. Cable and Richard A. McLean record the occurrence of *Cercaria clausi* Monticelli, a marine larval trematode, on the west coast of Florida (*Notulæ Naturæ*, Academy of Natural Sciences of Philadelphia, No. 129; 1943). This is a rare type of cercaria which has the peculiar habit of forming rosettes, the tails clinging together and the bodies sticking out from the centre of the mass. The present specimens were found inhabiting the marine prosobranch gastropod *Lamellaria leucosphæra*, which in captivity gave out the cercariæ. There is an interesting point, namely, that the host of this worm is recorded as both *Lamellaria leucosphæra* and *Trivia europea*. Recent classification places *Lamellaria* and *Trivia* very close together and both possess pelagic larvæ of the echinospira type. It may very well be that the miracidium enters the host when in this pelagic echinospira phase. A search for such larvæ might be fruitful and of interest. If this supposition were proved, it would indicate a final host which was pelagic and not of necessity living always in the near neighbourhood of the mollusc. Photographs are given of the larvæ in this paper, but clear drawings are much needed also.

## Sporulation in Yeast

C. C. Lindegren and E. Hamilton (*Bot. Gaz.*, **105**, 316; 1944) and C. C. Lindegren and G. Lindegren (*Bot. Gaz.*, **105**, 305; 1944) have discussed the process of spore formation in yeast. After describing a new medium which gives the maximum spore formation of cultures, they show that the genetic constitution has a considerable influence upon spore formation. Legitimately diploid strains sporulate regularly and well, whereas single-spore cultures which may be either haploid or illegitimately diploid are irregular and sparse. The analysis of forty baker's yeasts showed that some were diploid while others were of single spore origin. Sporulation occurs more readily at the edge of the colonies where many of the cells are autolysed. These cells may supply necessary nutrients for the sporulation. It was known from the work of Nickerson and Thieman that riboflavin and sodium glutarate were specific substances for conjugation and sporulation. The parallelism with the paraphyses in Pyrenomycetes and with the structure of bacterial colonies is pointed out. From the cytological investigations of Lindegren and of Badian it would appear that chromosomes exist in bacteria and that they undergo similar changes to those observed in higher plants. There are two chromosomes in the diplophase of yeast. In a further paper by C. C. Lindegren and G. Lindegren (*Proc. U.S. Nat. Acad. Sci.*, **29**, 306; 1944) it is shown that the four spores of one ascus of certain strains of *Saccharomyces cerevisece*, which persistently produce haploid cultures from single spores, are of two types. Pairing and sporulation occur regularly and easily between but not within these two types. It is believed that allelomorphs controlling incompatibility are present as in fungi. The authors confirm the fact that *Torula* forms are imperfect forms of *Saccharomyces* and when properly mated produce copulation tubes of the pattern of *Zygosaccharomyces*.

## *Iso*-allelomorphism

C. Stern and E. W. Schaeffer (*Proc. U.S. Nat. Acad. Sci.*, **29**, 361; 1944) provide evidence for an important aspect in evolution. Three strains of *D. melanogaster* were homozygous and similar, except for the genes on the fourth chromosome which contains cubitus interruptus. At normal culturing temperatures 25–26°, these three strains all appeared to contain the similar normal allelomorph of *ci*. When raised at 14° one strain gives *ci* type individuals as well as normal. When this locus containing the normal allelomorph is present in flies deficient for the partner chromosome (hemizygotes) a different strain produces *ci* type individuals. When tested as heterozygotes with *ci* and especially with *ciw*, the normal allelomorphs of *ci* in the three strains are further separated. These *iso*-alleles have been found in many loci in Drosophila and in other organisms previously. The importance of the *ci* case is that the wild types in the three strains tested were found to be different. The prevalence of these small genic differences which have no immediate striking or switch effect is of great importance in evolution.

## Pathogenicity of *Ophiobolus graminis*

THE complex pathogenicity of the fungus *Ophiobolus graminis* on cereals is discussed in a brief paper by N. H. White and G. A. McIntyre (*J. Coun. Sci. and Ind. Res. Australia*, **16**, 2; May 1943). Eight single-spore isolates of the organism, derived from

eight ascospores within a single ascus, were grown upon three different media and inoculated on two kinds of sandy loam soil. All three of these factors affected the pathogenicity. One strain produced no disease; another infected 89 per cent of the plants. Relative differences between isolates were not the same for different media, though straw medium was generally most suitable and soil medium least so. Differences in pathogenicity due to variation in cropping soil were usually small, but changed with the isolates. Any control of this fungus must therefore overcome the extreme variability of the pathogen.

### Composite Nature of Spotted Wilt Virus

D. O. NORRIS announces in a short note (*J. Coun. Sci. and Ind. Res. Australia*, 16, 2; May 1943) that the spotted wilt virus of tomatoes is a mixture of at least three strains. The virus was obtained from potatoes at Canberra, and the three components form necrotic, ringspot and mild symptoms respectively. The necrotic strain appears to be identical with tomato tip blight described by Milbrath (1939) in Oregon. This discovery should explain the many observed variations in the severity of spotted wilt, for the symptoms will thus vary according to the number and ratio of strains which are present.

### The Sprengnether Vertical Seismograph

WILLIAM SPRENGNETHER, JUN., of St. Louis, has designed an instrument to meet the demand for a simple, low-priced, short-period vertical-component seismograph of fairly high sensitivity (*Trans. Amer. Geophys. Union*, 1941). The frame consists of a rigid truss with a long hinge-bar at right angles to it. Above the rear end of the truss a weight is carried by a vertical bar on which it is adjustable in order to regulate the period by setting the centre of gravity in any desired relationship to the point of suspension from the spiral spring. The principal part of the mass consists of this counterweight and of a brass box at the forward end of the truss containing a pair of elliptical brass spools on which are wound flat coils; and to a lesser extent of a copper plate supported on a forward extension of the boom or truss, adding to the inertia mass of the moving system. The hinge consists of two pairs of thin crossed springs attached to the hinge-bar of the moving system and to a rigid cross-piece fastened to the frame. The coil-box is free to move between the poles of a large, powerful Alnico magnet. The copper plate moves between the poles of three pairs of commercial Alnico horseshoe magnets, by which critical damping is easily obtained. Wires are led from the coil-box over the frame to the neighbourhood of the hinge-line and thence to a galvanometer. The period chosen in the case of one such instrument used at Saint Louis University lies between the microseisms, which usually have periods of 4–7 sec., and the local traffic disturbances, which have periods less than a second. The magnification is about 3,000. The instrument not only produces good records of local earthquakes, but it will also react to the shorter periods in the beginning of distant earthquakes to such an extent as to produce a sharp record of the beginning where horizontal seismographs of moderate high sensitivity will fail to do so.

### Experimental Measurement of Irrigation Water

A PAPER with the title "Medición de las aguas en las estaciones experimentales de riego", by Prof. Juan L. Raggio, with the collaboration of Juan C. Dragonetti and Adolfo E. Foglia, describes the method adopted for measuring with precision the volumes of water used for irrigation purposes at the experimental station attached to the Institute of Mechanics and Hydraulics at the University of Buenos Aires (*Rev. Fac. Agron. y Vet.*, 10, 111; 1943). An account of the gauges which were used is supplied, and the previous work of Prof. Giulio De Marchi is utilized. He showed how a simple calculation could determine the dimensions of the gauge ("Dispositivi per la misura di quota". *L'Energia Elettrica*, published in 1936–37), and continuing the work on his lines, a study has been made of the hydraulic processes developed in the gauge. A brief description of the irrigation system of the station follows, and a full account is given of the experiments carried out with the gauge to determine the coefficient of expense for various volumes. The paper is illustrated by a number of diagrams and by a chart showing the relation between the theoretical and actual volumes of water and also the coefficient of expense. On the basis of 5·5 litres of water per second, it is shown that the errors existing between the theoretical and actual figures do not exceed 4 per cent. A short appendix deals with the experimental plant on which the agricultural hydraulics of the Faculty of Agriculture of the University of Buenos Aires depends and in which the gauge was utilized.

### Differential Corrections to Double Star Orbits

W. P. HIRST has shown how an approximate arithmetical method can be used for applying differential corrections to the elements of the orbit of a double star (*Mon. Not. Roy. Astro. Soc.*, 103, 6; 1943). The usual procedure for deriving these differential corrections by the method of least squares was criticized some years ago by van den Bos, who pointed out that the result obtained is scarcely worth the work, and also that the elements that make the sum of the squares of the residuals a minimum are not necessarily the most probable (*U.O. Circ.*, 98; 1937). He described in the same issue a graphical method based on the residuals in position angle only. This method consists of plotting the residuals in angle as ordinates against any convenient abscissæ, such as the mean anomaly, or even the serial number of the measure, and comparing this graph in turn with the graphs of the differential coefficients of the equation of condition in angle, plotted against the same abscissæ. The residual curve is corrected differentially after each comparison to remove any systematic resemblance between the residual curve and the coefficient curve. The residual curve is then compared with the next coefficient curve and again corrected, and so on, until no further resemblance with a coefficient curve can be detected. Hirst's method is based on that of van den Bos, but it is much less laborious, and is applied to the orbit of A.417 (A.D.S. 16497). It starts with the function $\delta\theta/\delta e$, which is zero at periastron and apastron, positive from periastron to apastron in the direction of motion, and negative in the other half of its orbit. Hence, if the preliminary value assigned to $e$ is too small there will be, on the average, an excess of positive residuals in the half of the orbit after periastron as compared with those in the half preceding periastron. On this basis, it is shown that very satisfactory results are obtained with much less labour than is involved in the least square method.

# MEDICAL DEVELOPMENTS IN FIJI

A FULL report of the address given by Dr. V. W. T. McGusty, director of medical services, Fiji, to the Legislative Council on plans for the future of medicine in Fiji and its neighbouring island groups is given in the *Fiji Times and Herald* of February 24, 1944; and a leading article in the journal warmly commends these plans.

Dr. McGusty also gives in his address a very interesting history of medical progress in that part of the world. It is clear from what he says, from his discussions of his plans with the Colonial Office, from the approval of the plans by the Legislative Council, and from the discussions of the financial requirements of the reorganization proposed, that Fiji is going to incorporate in its medical services the medical developments which are now being organized in the Western world, and that it has both the ability and the personnel to make them as efficient as they are anywhere. The existing medical services are not to be thought of as being in any way primitive. The existing Central Medical School and the Nurses Training Centre and the Central Leper Hospital are joint services in which the New Zealand Government and the American administration of Samoa take part; and the Western Pacific Territories and the Australian Government are also concerned with some of them. All these services are discussed in Council Papers Nos. 2, 3 and 18*.

The difficulties of the medical man in these island groups, his Odysseys in conditions of bad weather and difficult landings in surf-boats, and the remarkably efficient help which the European or American practitioner gets from the keen and well-trained Fijian medical practitioners, are described by Dr. McGusty in this address and also in an article which he contributes to the *Native Medical Practitioner* (Vol. 3, No. 3; Sept. 1941), which is the journal of the Central Medical School, Suva. Other articles in this journal by native medical men and nurses show that Dr. McGusty's praise of them is well founded. There is an eagerness about their writing, and a desire to relieve suffering, which indicates a refreshing and noble realization of their mission. "I hope, sir," one of them writes in his report on seven weeks work on the island of Tongoa, "that you will enjoy reading this brief account of my first start in the New Hebrides." "Hoping," he concludes, "that all the students are working hard at their studies, and with best regards to you, sir, and all the students, your obedient N.M.P. and old student, A. K. Manulevu." What teacher would not be proud to receive such a letter and to do all he can to save such a race from extinction?

For it amounts to that—no less. "If serious infectious diseases," Dr. McGusty says, "such as malaria, can be kept out of Fiji, the Fijian race may survive." While tuberculosis is still the greatest single disease problem, the danger of the introduction of other diseases which can wipe out populations has always been a menace to Fijian medical care. The geographical position of Fiji renders it likely to become an important junction for civil air traffic after the War, so that its health problems will have more than a local interest. New Zealand is also extending its medical organization and desires closer co-operation with Fiji and the Western Pacific.

Fiji was discovered by Tasman in 1643 and, until the first Europeans arrived at the end of the eighteenth century, the infectious diseases of Western civilization were unknown to Fijians. After 1790, native folk-lore and other sources spoke of epidemics which took toll of a population of some 250,000, but this number had fallen fifty years later to 150,000. Protestant and Catholic missionaries probably introduced diseases, but they were, says Dr. McGusty, the only people who could control them or alleviate suffering, and full credit must be given to them for their work. The cotton boom brought more Europeans and more disease. The late King Cakobau, a very wise ruler, unified the country and led it into the care of Great Britain, to the colonizing power of which Dr. McGusty pays a warm tribute. The Fijian race was nearly wiped out in 1875 by an epidemic of measles which killed 40,000 people. The risk of the introduction of further infectious diseases was, however, vigorously combated by Sir William MacGregor, who instituted strict quarantine barriers, the vaccination of the people and the training of native youths to vaccinate and to practise medicine among their own people. This policy was carried on by Drs. Corney, Lynch and Montague.

The fight against infant mortality, which became serious enough to threaten the progress of the native races, was taken up in earnest, and further increase was checked by Miss Anderson's scheme for training Fijian girls as midwives and nurses. Miss M. L. Lea, principal matron of the Central Nursing School, tells us, in Council Paper No. 18, the history of this school and of its nursing services. Native methods of childbirth and artificial feeding are described in the *Native Medical Practitioner* (Vol. 3, No. 3; 1941), and from these accounts it appears that babies fed entirely on coco-nut prepared in various ways until they are more than eighteen months old may be as healthy as those that are breast-fed. Western methods are, however, rapidly effecting desirable improvements. Dr. McGusty, in his address, pays a high tribute to the work of the experts sent into these island groups by the Rockefeller Foundation, and in particular to the work of Dr. S. M. Lambert. Valuable also has been the opening to other island groups, by courtesy of the New Zealand Government and other authorities, of the Leper Hospital at Makongai. Half the deaths in this hospital in 1942 were Indians, a fact which may be considered together with the fact that the Indian population had, by 1942, risen to within 4,000 of the Fijian, and is expected to overtake and surpass it.

It is clear that the Government's plan to unify the medical services of all these island groups under the control of Fiji will do much to ensure the success of its scheme of improvement. The participation of New Zealand will be invited, and a director-general of public health and medical services for Fiji and the Western Pacific would be appointed, with a deputy director. The scheme includes the building, on a new site with adequate transport and facilities for expansion, of a new central hospital in Fiji of not less than 300 beds, an obstetric hospital of not less than 20 beds, a medical school for 80 medical students including 8 dental students, a nursing school for 150 students and a public health centre. The existing Suva Hospital, which is inadequate in size and equipment, could be altered to accommodate the

* Legislative Council, Fiji. Council Paper No. 18: Annual Report of the Medical Department for 1942. Pp. 24. Council Paper No. 2. Post War Reconstruction: Fiji and Western Pacific. Council Paper No. 3. Report on Public Health and Medical Services in the Colony of Fiji. (Suva: Government Printer, 1943–44.)

Public Health Centre and the administration of the Joint Pacific Public Health Authority and of the Medical Department of Fiji. In addition, it is proposed to use the buildings of the existing Colonial War Memorial Hospital, erected in 1923 to commemorate the fallen in the War of 1914–18, as a new and well-equipped isolation hospital. There will also be four regional hospitals, and the provincial hospitals will be improved. Modern research laboratories, built in 1936 with the help of the Rockefeller Foundation and of Lord Trent, are also available and adequate for present needs.

Of special general interest in view of the precautions which are being taken, all over the world, against the spread of disease in these days of fast transport and aerial travel, are Dr. McGusty's remarks about malaria. Malaria-carrying mosquitoes did not reach Fiji even in the days of sailing ships, although no special precautions were taken to prevent their entry. Dr. McGusty suggests that the south-east trade winds delayed the ships and washed their decks with salt spray, and also that their water-casks were always filled from fast-running streams in which mosquito larvæ did not develop. But the present War has brought an immense volume of traffic by sea and air, and it is a great tribute to the British and United States navy and army authorities that the precautions they have taken have so far kept malaria out of Fiji. How fatal to Fijians its entry might be, and how vital these precautions are, will be realized by those who have read the note in *Nature* of May 20, 1944, p. 625, on the importance of all human parasites in times of war, and on the very serious results which may follow their attack on populations which are not accustomed to them.

Council Paper No. 3, which is a report on the public health and medical services of Fiji made by Dr. Watt, director general of health, New Zealand, and Miss Lambie, director of nursing, New Zealand (the Watt-Lambie Report), illustrates the co-operation between Fiji and New Zealand which the Legislative Council of Fiji wishes to encourage. This report is not merely a report on the health of Fiji; it is also a valuable essay in modern public health practice. Plague and smallpox are, it points out, constant menaces to countries in the Pacific. They can be combated by the quarantine system and measures for rat control recommended by the report and by vaccination for smallpox. The importance of keeping out anopheline mosquitoes is emphasized. The other quarantinable Fijian diseases are yellow fever, cholera and typhus. The recent discovery of the efficacy of *DDT* as a means of killing the lice which transmit typhus and its successful application to large numbers of people in Naples recently should greatly assist the control of this disease in Fiji as well as elsewhere in the world, if, indeed, it does not check its ravages completely. The principal infectious diseases in Fiji are tuberculosis, typhoid fever, dysentery, diphtheria (which is not a major problem) and yaws and hook-worm (which are being well handled).

Tuberculosis is a serious problem in all native races and this report recommends mass miniature radiography, as well as the other measures usually used for its control. Local housing standards are usually good, but it is feared that tuberculosis may increase as the number of town dwellers increases. The pasteurization of milk in the larger communities, or in some places the boiling of it, are recommended, and this should help in the control of tuberculosis as well as that of typhoid and some other illnesses. The control of typhoid and dysentery depends upon safe milk, water and food and on efficient sanitation and general cleanliness. Better supervision of meat supplies and of milk production and improvement of housing, drainage and sewage disposal are required in some areas. The report discusses in some detail the organization and staff of the medical department, the maternal and child-welfare services and the existing hospital services (reports on the last-named constitute an appendix to the report). Other sections of the report deal with the medical, dental and nursing services and with medical and health education. The criticisms of these are, in the main, met by the scheme of reorganization outlined above.

The authors of the report think that Fiji will become a natural centre for medical research and education for the various island groups of the South Pacific. Its excellent climate and freedom from malaria and other tropical diseases should help this development.

Everyone will wish success to the medical authorities of Fiji in the carrying out of this beneficent scheme. The peoples of these island groups deserve all that we can do for them when, before very long, their sunny land will be freed from the shadow which has recently menaced their future. G. LAPAGE.

# FEDERAL ACTIVITY IN AMERICAN EDUCATION

IT is not easy, for a non-American, to understand why each of the forty-eight States of America should be educationally autonomous, and why therefore it is difficult for anyone to speak for American education as a whole. This is but one aspect of the opposition between Federal Government and State rights—a matter incomprehensible to a person who is unacquainted with the broad lines of American history and has never travelled in the United States. But war is a national effort, and must be conducted by the nation, in this case with powerful collateral effects upon the forty-eight educational systems. Thus the United States Office of Education at Washington, headed by the U.S. Commissioner of Education, is extremely active, and by the use of the funds provided by the Federal Government for educational purposes is able to promote the ends of a nation at war. So much is made clear by the Annual Reports of the U.S. Office of Education 1941–2 and 1942–3, by the pamphlet entitled "Federal Government Funds for Education 1940–1 and 1941–2", and by the official bi-weekly journal *Education for Victory*, which replaces *School Life* for the duration of the War, and which is specially addressed to all American youth.

Among the war-time causes aided by the U.S. Office of Education agriculture takes a very prominent place, followed by vocational education, vocational rehabilitation, national defence training, library service, adjustment of college curricula to meet war-time needs, teacher personnel problems, not to speak of a long list of less important subjects.

Another way in which the U.S. Office of Education conveniently speaks for America as a nation is exemplified by pamphlets entitled "Inter-American Education: A Curriculum Guide", and "Education in Cuba". The former represents a concerted effort on the part of the U.S. Office of Education to establish a plan for making the study of the other American

republics an integral part of the curriculum in primary and secondary schools. The latter is one of several basic studies on education in the other American republics planned as a part of a programme to promote better understanding of education in the Latin-American countries and to encourage closer educational co-operation.

The U.S. Office of Education does not limit its educational surveys to the American continent, but extends them to the wider field of what is known as comparative education. A good example is Leaflet No. 69, which provides a clear and interesting report on "Education in China To-day". The report shows how, despite the invasion of her best developed educational centres, China is to-day demonstrating an unshakable confidence in public education. It seems quite obvious that the Central Office of Education in the United States is doing most valuable work which does not fall within the purview of any one of the forty-eight States.

## RESTORATION OF THE LENINGRAD INSTITUTE FOR PLANT CULTURE

By IVAN BONDARENKO*

BEFORE the War, the Leningrad Institute for Plant Culture had formed a valuable collection of seeds of many species of plants. When the siege of the city began, most of the scientific workers were evacuated into the interior of the U.S.S.R., but the seed collection had to be left behind at Leningrad. As soon as the city was freed, the workers returned.

Johann Eichfeld, who came back with a number of assistants, began re-sorting the collection; in the early spring he sent about ten thousand samples of various seeds to different parts of the Soviet Union with the request that they should be planted and a report on the growth furnished to the Institute. Telegrams have already been received reporting results from the Urals, North Caucasus, the Moscow region and Central Asia; in nearly all cases the results have been normal. This shows that, in the main, the collection has not been disturbed, and that with its help new research can be undertaken and the task of helping the restoration of regions devastated by the Germans can be tackled.

The Institute workers are now busy rebuilding their experimental station, which is situated three miles from Pavlovsk near Leningrad. This was formerly a big experimental farm where there were about two hundred varieties of fruits, three thousand varieties of berry fruits (including the only collection of gooseberries in the U.S.S.R.), about fifty thousand hybrid fruit trees and bushes, and many flowers and decorative plants. The station had cherries which ripen quickly in the short summer of this district, with some very fine varieties of strawberries, black-currants, plums and apples.

The German invaders destroyed the greenhouses, laboratories, seed stores, dwelling-houses and other buildings on the station. Many collections of plants were taken away to Germany, and those that were left were badly neglected. People from neighbouring villages and some ex-marines are now helping to rebuild the station.

Under the guidance of Profs. Fedor Teterev and Roman Cordon, houses are being rebuilt and implements repaired. The plantations of shrub fruits and the orchards are being dug over. Seed is being prepared for rapid distribution. It is expected that in the autumn of 1944 and the spring of 1945 the Institute will provide farm nurseries with 100,000 strawberry cuttings, 50,000 young fruit trees, 60,000 currant bushes and many other plants. At the same time, rapid distribution of various plants is being organized so that by next summer some 3,000,000 saplings and cuttings of fruit trees and bushes will be ready. Extensive plans for scientific research work are also being made.

* Transcribed by A. Clifford.

## EARTHQUAKES DURING THE SECOND QUARTER OF 1944

DURING April and May, twenty-six strong earthquakes were registered by the instruments at Toledo (Spain), and ten by the seismographs at Wellington, New Zealand. In addition, twenty-five earthquakes were felt by people in some parts of New Zealand. During April 26–June 25, eight epicentres were determined from instrumental evidence by the United States Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association. On April 26 an earthquake originated at 1h. 53·9m. G.M.T. from a provisional epicentre at 1° S., 131° E., in western New Guinea. It was registered by the instruments at eleven United States observatories, and also at Toledo and Wellington. An after-shock from the same epicentre had its origin time at 14h. 37·9m. G.M.T. on April 27. This was registered at Toledo and Wellington and was reported from fifteen other stations in the United States, Australia and the Pacific Islands.

The earthquake of May 6 originated at 0h. 13·7m. G.M.T. from an epicentre at 22·4° N., 44·8° W., in mid-Atlantic. It was registered at nine American observatories and at Toledo, but not at Wellington, in any strength. The shock of May 25 at 1h. 06m. 39s. G.M.T. originated at 21·5° S., 179·0° W. in the Tonga Islands, with a depth of focus probably greater than 600 km. It has been reported from sixteen observatories in the United States, Pacific Islands, New Zealand and Toledo. This earthquake was world shaking, and attained a maximum ground amplitude at Toledo of 45 μ. Also on May 25 there occurred another shock at 12h. 58·1m. G.M.T. This time it was from an epicentre at 3° S., 152° E., in New Ireland. It was registered at fourteen stations in the United States, Pacific Islands, New Zealand and Toledo.

On June 16 an earthquake was registered at nine American observatories, and its epicentre as provisionally determined by the U.S. Coast and Geodetic Survey was at lat. 19° N., long. 105° W. Its origin time was 21h. 51·5m. G.M.T. The shock of June 21 originated in the New Hebrides (21·5° S., 169·8° E.) at 10h. 58·3m. G.M.T., and that of June 25 originated in mid-Atlantic (1° S., 25° W.) at 17h. 42·2m. G.M.T. according to the determination based on reports from Fordham, Huancayo, San Juan and Spring Hill.

In New Zealand the strongest earthquakes to be felt had strength IV on the modified Mercalli scale. These were reported as follows: April 17 at Porangahau, April 22 at Blenheim, Cook Strait and Wellington, April 30 at Tolaga Bay, May 16 in the Takaka region and May 20 at Rotorua. On May 9 an earth tremor was felt at Wairoa and Napier with scale III, and some inhabitants of Napier again felt a shock with scale III on May 31.

# FORTHCOMING EVENTS

*(Meeting marked with an asterisk is open to the public)*

### Saturday, September 30

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1), at 2.30 p.m.—Prof. F. C. Thompson: "Some Fundamental Work on Austempering and the Isothermal Transformation of Austenite".

### Monday, October 2

SOCIETY OF CHEMICAL INDUSTRY (YORKSHIRE SECTION) (at the Metropole Hotel, King Street, Leeds), at 6 p.m.—Dr. A. L. Roberts: "Drying by Infra-Red Radiation".

### Tuesday, October 3

CHADWICK LECTURE (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 2.30 p.m.—The Rt. Hon. Lord Amulree: "Water Supplies in Peace and War".*

### Wednesday, October 4

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 2.30 p.m.—Dr. H. R. Fehling: "Thermal Insulation".

ROYAL ENTOMOLOGICAL SOCIETY OF LONDON (at 41 Queen's Gate, South Kensington, London, S.W.7), at 3.30 p.m.—Mr. E. D. Eyles: Film of House-fly Alighting on Ceiling.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.15 p.m.—Inaugural Meeting of the Micro-chemical Group; at 3 p.m.—Dr. Janet W. Matthews: "The Development of Micro Methods in Analytical Chemistry"; at 3.45 p.m.—Dr. A. A. Houghton: "The Micro-determination of Carbon by Wet Combustion".

### Thursday, October 5

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Sir Harry Railing: Inaugural Address.

### Friday, October 6

ASSOCIATION OF APPLIED BIOLOGISTS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11.30 a.m.—Dr. J. W. Evans: "Applied Biology in Tasmania"; Dr. C. B. Williams: "Applied Entomology in South America".

### Saturday, October 7

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. A. D. Lacaille: "The Northward March of Palæolithic Man in Britain".

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER AND DEMONSTRATOR IN GEOLOGY, with special qualifications in Mineralogy and Petrology—The Registrar, University College of South Wales, Cardiff (October 2).

PATENT AGENT of British nationality, preferably specializing in Electronics, by a well-established firm (subjects: mechanism, control apparatus, electronics)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2592.XA) (October 2).

PRINCIPAL of the Oldham Municipal Technical College—The Director of Education, Education Offices, Union Street West, Oldham (October 6).

PSYCHIATRIST (part-time) at the Child Guidance Clinic—The Chief Education Officer, Education Offices, York (October 7).

ASSISTANT MASTER with qualifications in CHEMISTRY at the Portsmouth Junior Technical School (evacuated to Salisbury)—The Education Offices, Northern Secondary School, Mayfield Road, Portsmouth (October 7).

LECTURER for ENGINEERING SUBJECTS to take two of the following: Preliminary Mathematics, Technical Drawing, General Science, in the Southampton Technical School—The Secretary, Education Office, Civic Centre, Southampton (October 7).

ASSISTANT (temporary) TO THE ADVISORY BACTERIOLOGIST—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (October 7).

BOROUGH ELECTRICAL ENGINEER—The Town Clerk, Municipal Offices, High Wycombe, Bucks. (October 9).

SENIOR ASSISTANT DRAINAGE AND IRRIGATION ENGINEER (Reference No. E.902.A), and a JUNIOR ASSISTANT DRAINAGE AND IRRIGATION ENGINEER (Reference No. E.903.A) by the Sierra Leone Government—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting the appropriate Reference No.) (October 9).

ASSISTANT PLANT ENGINEER (Graduate in Chemical or Electrical Engineering, with experience in Design, Installation and Operation of Chemical Engineering Plant, including Small Electric Furnaces) in the Midlands—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2222.XA) (October 9).

SPEECH THERAPIST (full-time) for duties in the areas of the Bridgwater, Taunton and Yeovil Education Committees—The Clerk to the Taunton Borough Education Committee, Education Office, Municipal Buildings, Taunton (October 9).

ASSISTANT LECTURER (full-time) IN MINING in the Cannock Chase Mining College—The Director of Education, County Education Offices, Stafford (October 9).

LECTURER IN ENGINEERING IN WEST AFRICA—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.836.A) (October 15).

LECTURER IN PHARMACEUTICAL SUBJECTS in the School of Pharmacy—The Principal, Leicester College of Technology and Commerce, Leicester (October 19).

RESEARCH OFFICER in the Institute for Research in Agricultural Economics—The Secretary, Institute for Research in Agricultural Economics, Parks Road, Oxford (October 23).

TEACHER OF MATHEMATICS, mainly for work in the Day Technical School for Boys and in Day Classes for apprentices in the Technical Institute—The District Secretary, Kent Education Committee, 13 Tonbridge Road, Maidstone.

MASTER (or MISTRESS) to teach MATHEMATICS, chiefly in the Day Technical School for Boys—The Principal, Technical Institute, Tunbridge Wells, Kent.

CHIEF OF THE DEVELOPMENT DEPARTMENT—The Secretary, British Cast Iron Research Association, Alvechurch, Birmingham.

PHYSICIST OR PHYSICAL CHEMIST (young, man or woman) for research work on the Rheology of Dairy Products, especially Cheese—The Secretary, National Institute for Research in Dairying, Shinfield, Berks.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

Scientific Proceedings of the Royal Dublin Society. Vol. 23 (N.S.), Nos. 17–26: Ascorbic Acid, Part 2, Factors Determining Stability in Aqueous Solution, by Einhart Kawerau and W. R. Fearon; Ascorbic Acid, Part 3, The Ascorbic Acid Content of Fruits and Vegetables Grown in Eire, by Einhart Kawerau; The Chemical Constituents of Lichens found in Ireland—*Cladonia sylvatica* (L.) Harm. emend. Sandst., by T. W. Breaden, Dr. J. Keane and Dr. T. J. Nolan; Sea Trout of the Waterville (Currane) River, by Arthur E. J. Went; Reaction of *p*-Dimethylaminobenzaldehyde with Aromatic Amino Compounds, by A. E. A. Werner; The Gametophytes of *Podocarpus andinus*, by W. J. Looby and J. Doyle; Report of the Radium Committee for the Year 1943; Studies in Peat, Part 11, Pear-Tar Oils, by J. Reilly, Patrick Moynihan and Desmond Reilly; Studies in Peat, Part 12, Mona Wax (Irish Peat Wax) and Emulsification, by J. C. Aherne and J. Reilly; Fertilization and Early Embryogeny in *Podocarpus andinus*, by W. J. Looby and J. Doyle. Pp. 171–270+plates 6–14. 15*s*. Vol. 23 (N.S.), No. 27: A Molecular Constant for Soured Milks, 3, Very Old Samples. By J. J. Ryan. Pp. 271–272. n.p. Vol. 23 (N.S.), No. 28: Observations on a Severe Strain of Potato Virus X. By Phyllis E. M. Clinch. Pp. 273–299+plates 15–17. 4*s*. 6*d*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [59

Cambridge Joint Advisory Committees. Syllabuses for Examinations taken by Sixth Form Pupils in Physics and Chemistry. Pp. 16. (London: Cambridge University Press.) 6*d*. [129

### Other Countries

Cornell University Agricultural Experiment Station. Bulletin 796: Wong, a Winter Barley for New York. By H. H. Love and W. T. Craig. Pp. 16. Bulletin 800: Consumer Demand for Apples and Oranges. By W. E. Black. Pp. 44. Bulletin 801: Regional Markets in New York State. By V. H. Nicholson. Pp. 48. Bulletin 803: Factors that Affect Incomes on Commercial Poultry Farms, 1940–41. By Lawrence B. Darrah. Pp. 40. Memoir 252: Lysimeter Experiments, 5: Comparative Effects of Ammonium Sulfate and Sodium Nitrate on Removal of Nitrogen and Calcium from the Soil. By J. A. Bizzell. Pp. 24. Memoir 253: Nitrous Acid and the Loss of Nitrogen. By J. K. Wilson. Pp. 36. Memoir 254: Comparative Study of Mouth Parts of Representative Hemiptera—Homoptera. By F. H. Butt. Pp. 20+8 plates. (Ithaca, N.Y.: Cornell University Agricultural Experiment Station.) [88

New South Wales: Department of Public Instruction, Technical Education Branch. Curator's Annual Report of the Technological Museum for the Year ended 31st December 1943. Pp. 4. (Sydney: Government Printer.) [148

Australasian Antarctic Expedition, 1911–14. Scientific Reports, Series A, Vol. 5: Macquarie Island, its Geography and Geology. By Sir Douglas Mawson, based mainly on the Records of Leslie Russel Blake. Pp. 194 (37 plates). (Sydney: Government Printer.) 35*s*. [158

Report and Accounts of the National Botanic Gardens of South Africa, Kirstenbosch Newlands, Cape (and the Karoo Garden, Whitehill, near Matjesfontein) for the Year ending 31st December 1943. Pp. 12. (Kirstenbosch: National Botanic Gardens.) [158

U.S. Department of State. Publication 2137: The Cultural-Co-operation Program, 1938–1943. Prepared by Haldore Hanson. Pp. 71. (Washington, D.C.: Government Printing Office.) 15 cents. [158

Indian Central Jute Committee. Technological Research Pamphlet No. 1: The Preparation and Spinning of Flax on Jute Machinery. By A. S. Gillies and C. R. Nodder. Pp. 8. (Calcutta: Indian Central Jute Committee.) 4 annas; 6*d*. [178

Post-War Forest Policy for India. A Note by Sir Herbert Howard. Pp. iv+49. (New Delhi: Government of India Press.) [178

U.S. Office of Education: Federal Security Agency. Leaflet No. 70: Federal Government Funds for Education 1940–41 and 1941–42. Pp. iv+36. (Washington, D.C.: Government Printing Office.) 10 cents. [218

Bernice P. Bishop Museum. Bulletin 179: Arts and Crafts of the Cook Islands. By Te Rangi Hiroa (Peter H. Buck). Pp. 534+16 plates. Bulletin 182: Report of the Director for 1943. By Peter H. Buck (Te Rangi Hiroa). Pp. 30. (Honolulu: Bernice P. Bishop Museum.) [218

# NATURE

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CONTENTS




*Editorial and Publishing Offices*

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## COUNCIL FOR BRITISH ARCHÆOLOGY

THE inter-war period 1919–39, now so generally criticized for failures in the political and economic arenas, may be found in retrospect to be a Golden Age in the development of the science of field archæology in Britain, comparable with the period of rapid advance in the science of geology in the first half of the nineteenth century. Pitt-Rivers laid its secure foundations in the late nineteenth century, and in the years since his death there has never been lacking one or more men imbued with his ideas, and utilizing his technique; but whereas such competent workers were, up to 1919, in a minority, their practice was thereafter standardized and developed in respect of both excavation methods and record. Improved mechanical devices such as air photography and the Rolleiflex camera, and ease of access to remote places brought about by the motor-car and road improvement, were also contributory causes.

The results of improved transport facilities in particular are reflected in the published work of the period. The motor-car enabled middle-aged archæologists to be on a site distant from habitation during the whole period of the working day without physical exhaustion; a 'travelling' earthwork such as Offa's Dyke could be subjected without difficulty to the scrutiny of one individual throughout its length; and widely distributed examples of any specific type of ancient structure could readily be studied by one person in the course of a single summer holiday. Hence field survey, in advance of or correlated with excavation, has flourished exceedingly. Collaboration with students of the natural sciences, brilliantly illustrated, for example, in the palæobotanical field (pollen analysis), has aided the rapid advance in knowledge of Britain's unwritten history.

Under the leadership of the Society of Antiquaries of London, the Society of Antiquaries of Scotland, and the Congress of Archæological Societies (founded in 1888) programmes of research were, during the years under consideration, co-ordinated, and sites for excavation selected for their probable contribution to the solution of outstanding problems of a period or locality, though local initiative was never supplanted. The same period saw the remarkable growth in scope and range of the Ancient Monuments Branch of H.M. Office of Works, charged under the Ancient Monuments Acts of 1913 and 1931 with the guardianship and preservation of monuments in State ownership, and with the protection of specific sites (scheduled monuments) deemed of national importance, though in private ownership. During the period when Sir Charles Peers was chief inspector of ancient monuments, the governing principles and standards of preservation work were established; and these compare favourably with anything achieved elsewhere, though the safeguards against damage and destruction of scheduled monuments did not prove altogether satisfactory. The appointment of an archæology officer to the Ordnance Survey in 1921 led *inter alia* to the production of a remarkable series

of period distribution maps on a national basis; for example, long barrows and megaliths, Roman Britain, the Dark Ages. These illustrated the laws governing human settlement in early times—the relation of man to his environment—as expounded by O. G. S. Crawford and others, and now generally accepted by archæologists and geographers alike. Perhaps the main weakness during these years was a lack of understanding of the significance of these widespread activities, even on the part of the educated public, among whom the concept of archæology as a 'treasure hunt' still lingered.

The War has in part interrupted and in part modified this progress; field work has been undertaken of necessity, not of choice. Service and other departments have taken over large tracts of land, many of which included sites and structures of archæological interest, and these it was clear could not be preserved. Thus a unique opportunity was presented of excavating under State auspices, and at State expense, ancient sites thus accidentally involved. When the full story can be told, it will be realized that a great gain in knowledge and technical experience among field workers stands to the credit of the Ancient Monuments Branch of the Ministry of Works, which has organized this process of salvage, as well as to the Service departments for their enlightened and fruitful collaboration.

Conscious of the problems of the post-war years, archæologists have been stocktaking; a lively conference, held under the auspices of the Institute of Archæology of the University of London in August of last year, discussed "The Future of Archæology" at home (and abroad)*; divergence of views on the desirability of State help and control was noticeable, unanimity of view on the importance of education—the technical training of archæologists themselves and the diffusion of knowledge among teachers of the archæological approach to the past. One fact was at the back of all thoughts and all discussion of the future of archæology in Britain. As a result of bombardment, English cities of known antiquity have had great areas laid waste, London, Southampton, Exeter, Canterbury being outstanding examples, and plans for reconstruction may involve further demolitions. Thus the post-war period, as is now well recognized, offers a great opportunity, by the intensive study, prior to rebuilding, of the remains of ancient structures and stratified deposits in such areas, of recovering much of the history of our most important urban centres. This opportunity can never recur, for modern methods of construction of commercial buildings involve deep disturbance and removal of the relic-bearing accumulation of soil.

Hitherto there has been no central organization with a claim to speak authoritatively for British archæology as a whole, ranging from the study of Palæolithic man to that of his Victorian descendants, and the necessity for such an organization was now generally felt. On the initiative of the Roman Society, consultations were held during 1942–43 at the invitation of the Society of Antiquaries of London, under the chairmanship of the president, Mr. (now Sir) Alfred Clapham, and resulted in the formation of a Council for British Archæology, which held its first meeting in March, 1944. As at present constituted, it consists of upwards of a hundred members, representing national archæological societies, county and local societies regionally grouped, unive sities and colleges in which archæology is taught, national museums, the regional museums' federations, and certain societies with kindred interests: the Council has appointed an executive committee, organized its members into regional groups, and set up consultant panels of experts for periods from the Palæolithic to the Renaissance. It is also inviting the collaboration in an advisory capacity of persons eminent in the natural sciences. As a tribute to the status of the Society of Antiquaries of London and the particular services it gave in connexion with the formation of the Council, the first president, who will hold office for three years, will be the president of the Society, Sir Cyril Fox; the honorary secretary is Miss K. M. Kenyon, of the Institute of Archæology, Inner Circle, Regent's Park, London, N.W.1.

The Council is not intended to be an executive body; it will not undertake excavation. Its purpose is to ensure that archæological interests are not neglected in the future and to assist groups or individuals working to that end. It will, for example, urge the strengthening of existing measures for the care and preservation of historic buildings and antiquities, present a case for State aid in excavation as and when the magnitude of the task appears to be beyond the resources of existing societies' funds, and will co-operate, in its own field of interest, with the Museums' Association. It is pledged to work for the adequate recognition of archæology in the educational system of Great Britain and to further measures designed to enlighten the public concerning the records and monuments of the past. It will co-ordinate and facilitate the provision of expert advice on archæological matters. Its most urgent task will be to press upon the authorities concerned with reconstruction the importance of safeguarding archæological remains on sites affected by rebuilding or development; or if preservation is impracticable, of ensuring that scientific examination and record are made before destruction.

The first-fruits of the Council's work are already in evidence. An independent committee for Roman London has been formed, a deputation from which has been received by the Lord Mayor, to consider the many and various problems of the remains of *Londinium*, the great commercial and administrative centre that was the City's precursor, which lie some 20 ft. below present-day street-levels. But effective official and corporate action in these important matters, as in others with which the Council is concerned, depends ultimately on the sanction of public opinion, and the urgent need of educating the public is fully recognized.

Unenlightened persons may have argued that archæology has no practical value and that after the War all efforts should be devoted only to 'things that matter'. But archæology, especially of the earlier

* Occasional Papers, No. 5: University of London, Institute of Archaeology. Pp. 100. See also *Nature*, 152, 320 (1943).

periods, will surely be of real and practical value in the post-war world from two points of view. In the first place, it is an almost ideal hobby study, and a democracy which is ever reaching towards more pay and shorter hours of work must be careful to further intellectual leisure occupations. Field work in archæology can be undertaken during holiday periods and useful evidence exposed by many ordinary folk who take the trouble to undergo a not too arduous course of training. Thus can archæology contribute to that cultural training which is so essential alongside other social disciplines as distinct from the more direct vocational studies.

But more important still is the fact that in the study of archæology, particularly of prehistory, science and humanity meet: the subject is man, yet the methods of work and the discipline are strictly scientific. As a training for the young it is therefore ideal—the human interest is always there, and their minds are broadened by the problems and other subjects they are brought up against during their work, while the whole approach to the subject and to others, like geology, which are involved is scientific. It has indeed been urged that archæology should be included in the curricula of secondary, and even of senior, schools. This would involve the training of a number of teachers, but it is a goal well worth aiming at. One way to start the ball rolling would seem to be to urge on the commissioners in charge of the Civil Service schedules for entrance examinations the wisdom of including archæology among the optional subjects. Many of these are now included to test the mental capacity of the candidate rather than for their practical usefulness in the service he is entering, and archæologists can indeed claim that their subject is ideal from this point of view.

Once recognized by the Civil Service as an examination subject, those who regulate the schedules for the higher certificate examinations of schools, and even for the humbler school certificates, would quickly turn their attention to the problem of including it in their programmes too. Here would be a splendid opportunity for the new Council to help by urging the Government to give the lead. The fact that several eminent Civil servants are on the Council will ensure that its requests to authority are practical.

So also might the universities, in their post-war replanning of courses, consider archæology as a subject of study for those students in the faculties of science and arts and in the training departments who are not making the subject their principal study; for thus can archæology help to widen the scope of university studies.

In this and in the other ways already outlined it will be excellent if the newly formed Council will tackle the problem of educating the nation to the importance of the subject of archæology and of gaining official recognition thereof. This, together with its concern for the safeguarding of ancient sites and the co-ordination of archæological effort, will cause every archæologist, inarticulate spade-worker and ready-penned publicist alike, to welcome its formation as filling a need of which they have long been conscious.

# DYNAMICS OF SOCIAL SECURITY

## The Price of Social Security

By Gertrude Williams. (International Library of Sociology and Social Reconstruction.) Pp. vii+199. (London: Kegan Paul, Trench, Trubner and Co., Ltd., 1944.) 12s. 6d. net.

MRS. GERTRUDE WILLIAMS' book is as topical as its title suggests, but on other counts than would appear on the surface. It is in reference to the White Paper on Employment Policy that its significance chiefly lies; but it closes with a sound and constructive criticism of the Civil Service which is equally pertinent to discussion of the Assheton Report on the Training of Civil Servants. Fundamentally, the book is a study of the mobility of labour and, cogently as Mrs. Williams argues that a new mobility of labour must be part of the price to be paid for social security, it may well be doubted whether the emphasis placed by Sir William Beveridge on labour mobility, and on the selection and training of staff for the Ministry of Social Security with special regard to the functions of serving the public and understanding the human problems with which they will be concerned, is likely to reconcile those who purchase the book on the ground of their interest in social security or to find an answer to the question: Can we afford social security?

It would be unfortunate if such disappointment prejudiced the success of such an excellent exposition. Mrs. Williams is an able chronicler, and her descriptive writing is clear and not obscured with unnecessary detail. She has the knack of bringing out the main points and avoiding irrelevancies, and even the disappointed enthusiast for the Beveridge Plan should be grateful for the indications given of fundamental changes in our industrial structure which have a profound bearing on the practicability of that full employment policy which is postulated as Assumption C in the Beveridge Plan.

If the title is misleading, it is not irrelevant. Mrs. Williams is not concerned with the financial aspects of social security but with the economic, social and industrial consequences. She emphasizes the danger that improved social services may harden the arteries of the economic system. We have given up one set of incentives without even facing the fact that we need something to take their place, and her discussion of the psychological problems of adapting incentives to work to a changing world, and of how far a sense of social obligation can supersede hunger as a spur to effort, leads to the conclusion that we must pay the price of social security by instituting in peacetime as in war some degree of State control over occupational distribution.

The first three chapters of the book, in which Mrs. Williams analyses the factors which impede the mobility of labour, should be widely read as an exposition of the argument condensed into the sections on distribution of labour and mobility of labour in the White Paper on Employment Policy. The Government could desire no better justification for its arguments than this able study of the reasons why labour should be fully and continuously mobile if we are to take advantage of the opportunities given us by improved techniques and new knowledge, and why, on balance, mobility has decreased in spite of some factors tending towards its increase. The provision of maintenance during employment has reduced the urgency of the need for finding new

employment and thereby clogged the economic mechanism through which changing wage-levels affected the occupational and geographical redistribution of labour. The general effect of inter-war developments in unemployment maintenance has been to remove one set of incentives to work without replacing it by another, and in Great Britain we have only now, in the White Paper, faced the fact that we need something to take their place.

The mobility of labour is of course only one aspect of the problem of productivity or of full employment, but Mrs. Williams does not suggest that the price of social security is something to be paid by employee or employer only in the acceptance of compulsion or direction in peace-time. Equally important is the analysis, in her next two chapters, of labour control in war-time in Britain and of labour control in Germany and the U.S.S.R., which leads to the exposition in her final chapter of the administrative spade work that must precede any attempt to perpetuate labour controls in peace-time. The price of social security has to be paid in sound administration as well as in the acceptance by the individual of restrictions on freedom of choice of occupation, until the sense of social obligation is as powerful, and as unconsciously accepted, as is an underlying principle of conduct such as self-interest.

Despite Mrs. Williams' pragmatic approach to her subject, she is stronger at analysis and in defining the problem than in constructive suggestions for dealing with it. She stresses the importance of the educational approach to the development of new incentives, and senses the opportunities in the Government training centres, the Army Bureau of Current Affairs, the employment exchanges and the joint production committees, and her clear exposition makes the book highly stimulating to the imaginative reader. Much more might be done, as she indicates, in the way of vocational selection by utilizing the data in this field now being accumulated in the Forces. Again, Mrs. Williams points out that compulsory transfer to other jobs involves acceptance by the State of some measure of responsibility for welfare arrangements and wage standards.

The best part of this chapter is that in which, developing further ideas she has already voiced in the chapter "The Staff Problem" contributed to the volume "Social Security" edited by W. A. Robson, she discusses the reform of the Civil Service, which must also form part of the price of social security. Constructive long-term thinking and the exercise of the newer mental disciplines, she urges, is a Government function of the first importance. Here again, in pleading the importance of intelligence and statistics as a prelude to scientific policies based on known facts, she is in line with the White Paper; but in analysing the requirements of a Civil Service capable of integrating the work of the Ministries with the wider life of the community, she sees that it is not only in the Civil Service that reform is called for: a high standard of Ministerial statesmanship, she says, is the essential foundation of successful Government control, whether of labour mobility or of any other communal activity.

The similarity of thought and argument here is very close indeed to that of a recent admirable article in the *Political Quarterly* on "Government Administration and Efficiency" in a series on the post-war machinery of government. The analysis is of special interest in view of the recent report on the training of Civil servants, and elaborates further some points that are imperfectly covered in that report. In a single paragraph, Mrs. Williams anticipates a number of the more important recommendations of the report, but on the whole, within the limits of her argument, she is even more searching and suggestive.

This, then, is a book that is well written and should be well read. It has merits as a mere chronicle of developments in a comparatively limited economic field. It is even more valuable in its suggestions as to the way in which such institutions as industry, the trade unions and the Government machine must adapt themselves to the new functions that must be covered in an attempt to establish full employment and social security. For the rest, it has claims on the interest of the scientific worker as indicating what is involved in the elaboration of scientific policies and the application of the scientific method in human affairs. Further, within the limits to which she confines herself, Mrs. Williams has given a modest but no less admirable stimulant to the constructive thinking about the organization and administration of social and economic institutions on which the development, if not indeed the survival, of our democratic system depends. R. BRIGHTMAN.

## A NATURALIST IN THE HIGHLANDS

### Highland Naturalist

A Gamekeeper's Observations and Discoveries. By Dugald Macintyre. Pp. 240+8 plates. (London: Seeley, Service and Co., Ltd., n.d.) 12*s*. 6*d*. net.

DUGALD MACINTYRE is a Highland naturalist who has made his name as one of the leading observers of his time. He has during his long life had unusual opportunities for recording the habits of bird, beast and fish, and in him is the rare combination of the accurate recorder and the man who can set down clearly, simply and truthfully what he has seen and heard. Therefore, any book by Dugald Macintyre is of value.

In this volume the author weaves his observations into a number of short chapters. In each chapter is told the story of the life-history of some bird, animal or fish, and in that story are embodied the author's own observations.

We read (p. 80) of a gannet which, when diving for fish, pierced a guillemot right through with its sharp bill. Unable to rid itself of the dead guillemot, the gannet drifted about and finally came ashore exhausted, when a good human friend cut away the guillemot and thus saved its life. We read of a white grouse which, although a cock bird, was flushed from a nest he was making, while his mate had laid her first egg in her own nest close by. We read (p. 98) of the old white grouse actually dying as the author passed—falling from his roosting place on the steep hill-face and rolling past Dugald Macintyre in the dusk of a frosty winter's evening. The author attributes the old grouse's death to heart failure following on grouse disease. There are statements in this book which are difficult to check, and which in a naturalist of less standing might be looked upon with reserve. But in one of his earlier statements, no less surprising, Dugald Macintyre has been fully vindicated. It was in March 1913 that he wrote to the *Field*, saying that the common curlew was in the habit periodically of ejecting the lining membrane of

its gizzard by coughing. These lining membranes are light yellow pouch-like objects with the consistency of thin rubber, rolled up by the muscular coat of the gizzard wall before ejection. To Mr. Macintyre falls the credit of being the discoverer of this curious habit, now well attested.

The author, in a short chapter on the kite, suggests that it might be possible to reintroduce this bird into Scotland by placing its eggs in buzzards' nests. It is possible that, were a sufficient number of kites' eggs available, this might be done, but in Wales, the last nesting haunt of the species in Britain, the kite is still so scarce that I am very doubtful whether a clutch of eggs would be spared for the experiment. That is also the difficulty in the re-introduction of the osprey in the Highlands—the rareness of its eggs. Were some wealthy ornithologist to transport by air after the War a clutch of fresh osprey's eggs from Scandinavia to Scotland, and were these eggs to be placed in a nest of a buzzard already earmarked for this purpose, a brood of ospreys might be reared that would re-populate some Highland loch where the species formerly nested.

Mr. Macintyre is a keen angler, which is not surprising when one remembers his distinguished Highland ancestry. He is familiar not only with salmon, sea trout and brown trout, but also with the fish of Highland sea lochs and of the Atlantic. He describes the life-history of a pollack (or lythe as it is named in Scotland) which when caught turned the scales at 19 lb. That is a great weight for a pollack, but the fishermen who at times fish for these strong fish around the ocean rock of Sgeir nam Maol, in the Minch off northern Skye (where the owner of an ocean-going yacht told me that he caught heavier lythe than anywhere else off the British coasts) say that a 20-lb. lythe is not unknown here. My heaviest lythe was just over 16 lb., and my wife caught one of 16½ lb., but recently these fish have been much smaller.

Seton Gordon.

## COMMERCIAL FORESTRY IN THE UNITED STATES

**American Silvics and Silviculture**

By Prof. Edward G. Cheyney. Pp. x+472. (Minneapolis: University of Minnesota Press; London: Oxford University Press, 1942.) 30*s*. net.

PROF. EDWARD G. CHEYNEY has written in this volume a very useful and comprehensive compilation on the American aspects of the sylviculture of some hundred and fifty commercially important forest species. His book is said to be—and many will agree—the first attempt at treating this branch of forestry in America from the fully practical side. Sylviculture, he explains, has been developed in Europe as an art through centuries of experience with European species of trees. "Out of that experience has come a series of silvicultural patterns that can be useful in America when we have learned to adapt and apply them to our own species. In themselves the patterns mean but little. To use them we must have knowledge of the factors that influence the growth of trees in competition with each other, of the types in which American species group themselves, and of the silvical characteristics of our more important species." It has been the aim of the author to deal as fully as present information permits with his definition, and his book discloses how admirably he has carried out his object.

In connexion with sylviculture as gradually developed in Europe, the author correctly says that what he terms the sylvicultural patterns, that is, the various sylvicultural systems, will have to be adapted in order to apply them to American species. The recognition of this important factor applies, where forestry is one of the national assets, to almost every country in the world outside Europe. India would appear to be the first country to which this realization, through its Forest Service, came—but only after a period of years during which rigid copies of purely European practice had shown their fallibilities. In that country for many years past the sylviculturist has recognized the necessity of modifying and adapting to local and varying conditions the text-book definitions, perfectly sound ones for Europe, of the sylvicultural systems. It appears curious, therefore, that Prof. Cheyney, in the careful research and consideration he has given to his subject, should have apparently ignored the great amount of work carried out in this direction throughout India and Burma during the past forty years. It is the reviewer's belief that America could find some adaptations or modifications of the systems now adopted in India as forms of practical management which could be of use to conditions in parts of the country, especially in the transition from virgin forest to a forest under a correct and detailed management.

The book is divided into four parts. The first three are written as a text-book on forestry. Part 4 deals with the sylvicultural description of all the important species. In Part 1, sylvicultural factors are dealt with. Part 2, which is very informative, discusses the forest regions of the United States under forests of the Northern Region, forests of the Appalachian Region, forests of the Atlantic and Gulf Coastal Plains, forests of the Lake States, forests of the Rocky Mountains, forests of the Northern Pacific Coast and forests of the Southern Pacific Coast. Part 3 treats of sylviculture in its elementary aspects, the sylvicultural systems, the application of the systems to the various forest types, thinnings and the disposal of slash. In Part 4 the species of trees given alphabetically are dealt with under range, types and associates, soil, moisture, light, and seed-production, growth management and resistance (to fire, pests and so forth).

In America, Prof. Cheyney's book is hailed as the first attempt to place sylviculture in its application to a correct management of the forests in its practical position. "His book deals with American sylviculture and constitutes the only discussion of its kind."

It is rightly said that the natural forests of the United States have contributed greatly to the country's development. It is equally true that in the past they have been greatly and often ignorantly exploited by the lumberman, with at times disastrous after-effects. Unfortunately this type exploitation has not ceased. "In the first year of World War II," it is said, "three-fourths of the entire cut lumber of the United States was absorbed by the War effort. All this indicates the immediate need for better forest management." In spite of the above statement, paper stocks are obviously still fairly abundant, for Prof. Cheyney's book is beautifully got up and is illustrated by many photographs lent for the purpose by the United States Forest Service.

E. P. Stebbing.

## On the Influence of Trades, Professions, and Occupations in the United States, in the Production of Disease

By Dr. Benjamin W. McCready, 1837. (Publications of the Institute of the History of Medicine, the Johns Hopkins University, Fourth Series: Bibliotheca Medica Americana, Vol. 4.) Pp. vii+129. (Baltimore, Md.: Johns Hopkins University, 1943.) 1.75 dollars.

THE study of industrial diseases is a subject which, for obvious reasons, received little attention from medical men until comparatively recent times. Bernardino Ramazzini's "De morbis artificum diatribum" of 1700 was the first comprehensive work on occupational diseases, and the second was that of Thackrah of Leeds published in 1831. This latter work and the growth of industrialization in the United States of America influenced the Medical Society of the State of New York to propose for a prize essay in 1835 the subject of "The influences of trades, professions and occupations in the United States in the production of disease". The winner of the prize was a twenty-three year old physician, Benjamin W. McCready, and his essay was first published in 1837. This book contains the original essay with a critical historical introduction by Genevieve Miller.

The essay consists of four sections, discussing thirty-one employments. The first deals with outdoor workers in agriculture, on canals and railways, labourers and seamen; the second describes the workers in the textile industry; the third deals with artisans and tradesmen; and the fourth with the professional men.

McCready saw that in many cases the industrial hazards of his day were caused as much by basic habits and environmental conditions as by any immediate dangers in the occupations. The remedies he proposed were simple—proper housing and ventilation, personal cleanliness, shorter working hours and more exercise.

The editor and publishers are to be congratulated on their reproduction of this important historical document.

## Civilization and Disease

By Prof. Henry E. Sigerist. Pp. xii+255+29 plates. (Ithaca, N.Y.: Cornell University Press; London: Oxford University Press, 1943.) 22*s*. 6*d*. net.

DISEASE has played a great part in the evolution of civilization. Dr. Sigerist develops the theme and demonstrates the interrelationship in its many aspects in the course of human history. He begins by describing the influence of external factors of living conditions, clothing, lighting and nutrition on the genesis of disease, and then passes on to particulars. Economic and industrial changes and their effects on the character of disease are illustrated by reference to the works of Ramazzini, McCready and Thackrah. The position of the sick in society has greatly changed from the earliest days, when they were ostracized as in the case of lepers or horribly confined if mentally ill. In the complex modern society, many sick persons can usefully be employed in selected occupations.

The law appears in the establishment of quarantines, in the licensing and regularization of medical practice, and in public health and industrial organization.

The course of history has at all times been subject to influence by disease in epidemic form, and reference is made to the effects of plague, typhus and malaria on the results of battle and on distribution of population.

Towards the end, Dr. Sigerist becomes discursive and sketches over the relationship between religion, metaphysics, science, the arts and disease.

The subject-matter of this book was first used as a series of lectures, and this is apparent in the style. The wideness of scope and paucity of detail make this very readable book more suitable for the sociologist and lay reader than for the student of the history of medicine. The volume is beautifully produced, and has excellent and interesting illustrations.

## Thermionic Valve Circuits

By Dr. Emrys Williams. Second edition. Pp. viii+207. (London: Sir Isaac Pitman and Sons, Ltd., 1944.) 12*s*. 6*d*. net.

THE first edition of this book was reviewed in *Nature* of July 18, 1942. According to the author's preface: "The appearance of a second edition of this book has been hastened by the extensive consumption of the first edition by the enemy Luftwaffe". The opportunity has been taken to increase the size by some 15 per cent, by a general expansion of the existing chapters. New material has been added dealing with such subjects as frequency modulation, gas-filled valves, time bases, the Kipp relay, the transitron and the cathode follower; but the author has rightly resisted any inclination to go too far in meeting the general criticism of incompleteness. The book remains a very good survey of all the main types of valve circuits, presented in such a way that the student may be in a position to understand, or even foresee, further developments.

## Pacific Ocean Handbook

By Eliot G. Mears. Pp. viii+192. (Stanford University, Calif.: James Ladd Delkin, 1944.) 1 dollar.

PROF. ELIOT G. MEARS, professor of geography in Stanford University, set himself a formidable task in compressing into less than two hundred small pages a survey of the current scientific knowledge of the Pacific Ocean and its adjacent lands. There are chapters on the structure of the basin, its islands, on the physical aspects of the waters including drifts and currents, and on every aspect of the climate and particularly the storms. Other chapters deal with navigation, magnetism and tides. All sections are amply illustrated with maps. When such a degree of condensation is demanded, minor slips are unavoidable; but on the whole the little volume is most informative on the scientific side and includes results of much recent work. There are also statistical appendixes and a folding map.

## Textbook of Histology for Medical Students

By Dr. Evelyn E. Hewer. Third edition. Pp. xii+364. (London: William Heinemann (Medical Books), Ltd., 1944.) 17*s*. 6*d*. net.

THE essentials of normal histology are simply stated in this short text-book. The illustrations are excellent, and the photomicrographs by E. V. Willmott deserve special mention. As a laboratory reference book for medical students engaged on practical histology or preparing for examinations, this could not be bettered.

# SOCIAL AND INDUSTRIAL INSURANCE IN GREAT BRITAIN

ALMOST two years after the publication of Sir William Beveridge's report on Social Insurance and Allied Services, the Government has issued two White Papers, Part 1 dealing with its proposals for social insurance generally (except for industrial injury) and for family allowances, and Part 2 with proposals for replacing the existing system of workmen's compensation by a new scheme of industrial injury insurance. The whole scheme follows the lines indicated by Sir William Beveridge more closely than the prolonged delay had led many to expect.

## Social Insurance

In introducing the proposals for social insurance (Part 1)* the White Paper states that the Government accepts as necessary prerequisites to an improved and comprehensive plan of social insurance the three assumptions on which the Beveridge plan was based: institution of a scheme of children's allowances; framing of a comprehensive health service; and the avoidance of mass unemployment. Proposals for a national health service have already been published, and the Government's policy for maintaining a high and stable level of employment after the War has been set forth in the White Paper on Employment Policy. Those for a scheme of family allowances are included in the present paper.

These proposals are based upon two principles: first that nothing should be done to remove from parents the responsibility of maintaining their children; and second, that it is in the national interest for the State to help parents to discharge that responsibility properly. The scheme is not intended to provide full maintenance for each child but is a general contribution to the needs of families with children. This purpose, in the Government's view, can best be attained if a substantial part of the benefit is given in kind, and the school meals and milk services will therefore be extended to make them available to pupils in primary and secondary schools in receipt of grant from the Ministry of Education or the Scottish Education Department. These benefits in kind will be free of cost to the parents and will be available to all children in a family attending school, including the first.

The cost to public funds of supplying meals and milk to children at school when the service has reached its full development is estimated at about £60 millions a year. While accepting the argument in the Beveridge Report that children's allowances should be non-contributory and met wholly out of taxation, and that no allowance should be paid in respect of the first child, the Government rejects the rate of 8*s.* a week suggested by Sir William Beveridge and proposes a weekly cash allowance of 5*s.* for all children after the first below school-leaving age and remaining at school until July 31 following their sixteenth birthday. When the parent is receiving benefit, 5*s.* will be added to the benefit in respect of the first child.

With the exception of this family allowance scheme, the Government has adhered to the principle that freedom from want must be achieved in the first instance by social insurance: benefits must be earned by contributions. It has also decided not only to increase the range and amount of benefits provided, but that the scheme as a whole shall embrace the entire population. Of the six fundamental principles on which the Beveridge plan was based, the Government has adopted five: flat rate of contribution; flat rate of subsistence benefit; unification of administrative responsibility; comprehensiveness; and classification. There has been no attempt to vary contributions with the earnings of those who make them: broadly, the principle adopted has been that of equal benefits for equal contributions. Contributors and beneficiaries are classified into six groups, differing in respect of the benefits they need and the contributions they must make to receive them. Adopting the principle that the administration of a single, comprehensive, universal scheme of social insurance must be unified and that the various unco-ordinated sections of the system of to-day must be brought within a single administrative framework, the Government proposes the establishment of a Ministry of Social Insurance responsible for the whole of social insurance. The administration of assistance will be kept separate from that of insurance, though the Minister of Social Insurance will be responsible to Parliament for both. The present responsibilities of public assistance authorities for the payment of assistance in cash will be transferred entirely to the Assistance Board.

The Government has not accepted the sixth principle of adequacy of benefit. In fixing the rates of benefit, the Government considered whether it would be practicable to adopt a subsistence basis for benefits, but has rejected this as impracticable on the ground that the linking of benefit to subsistence-rates might involve the frequent variation of benefit-rates in accordance with the cost of living, and also that social insurance must necessarily deal in averages of need and requirement. A high level of benefit must mean a high level of contribution, and the Government concludes that the right objective is a rate of benefit which provides a reasonable insurance against want and at the same time takes account of the maximum contribution which the great body of contributors can properly be asked to bear. There still remains the individual's opportunity to achieve for himself in sickness, old age, and other conditions of difficulty a standard of comfort and amenity which it is no part of a compulsory scheme of social insurance to provide. In reserve there must remain a scheme of national assistance designed to fill the inevitable gaps left by insurance, and to supplement them where an examination of individual needs shows that supplement is necessary. There is no reference to a unified means test as advocated in the Beveridge Report, but the supercession advocated in the latter of the present system of approved societies is accepted: the Government concludes that it is not practicable to retain 'approved societies' either as independent financial units or as agents in the administration of the scheme. The considerations leading the Government to this conclusion and the alternative proposals of the Report, together with the wider proposals submitted on behalf of the approved societies, are summarized in Appendix II of the White Paper.

The scheme proposed by the Government is compulsory and includes everybody. The population will be divided into six classes: employees; the self-employed; housewives; adults who do not earn; children; and people over working age. It thus applies to large categories not hitherto covered

* Social Insurance. Part 1. (Cmd. 6550.) Pp. 64. (London: H.M. Stationery Office, 1944.) 6*d.* net.

by insurance; for example, those living on earnings gained otherwise than by salary or wages, or on earnings above £420 a year or on private income, and those employed in professions or industries hitherto specially excepted. Each insured person will pay a single weekly contribution for all benefits in the form of one stamp on a single document. For employed persons the stamp will also include the contribution for insurance against industrial injury. The first, second and fourth will be the contributing classes, and the rates of weekly contribution for persons over 18 (covering for Class I the benefits under the Industrial Injury Insurance Scheme as well as the Social Insurance Scheme) will be:

| | Class I | | | Class II | Class IV |
|---|---|---|---|---|---|
| | Insured Person s. d. | Employer s. d. | Total s. d. | s. d. | s. d. |
| Men: | | | | | |
| Aged 18 and over | 3 10 | 3 1 | 6 11 | 4 2 | 3 4 |
| ,, 16–18 | 2 5 | 2 1 | 4 6 | 2 9 | 2 2 |
| Women: | | | | | |
| Aged 18 and over | 3 0 | 2 5 | 5 5 | 3 6 | 2 8 |
| ,, 16–18 | 2 0 | 1 7 | 3 7 | 2 5 | 1 10 |

There will be a standard rate of benefit of 40*s*. a week for a married couple and 24*s*. for a single man or woman, with lower rates for those less than 18. Sickness benefit will end after three years of continuous disability, and invalidity benefit at the standard retirement pension will be substituted. Unemployment benefit will be paid up to a limit of thirty weeks in a continuous period, together with additional days where the contributor has a good record of employment. After the end of either benefit, further contributions must be paid before an insured person can re-qualify for benefit. Special allowances at a higher rate will be available to persons undergoing a course of approved training, but such training allowances will not form part of the social insurance scheme but will be paid out of taxation. There is no condition, as in the Beveridge plan, of unemployment benefit being subject after a certain period to attendance at a work or training centre, and this, like the limitation of benefit, is a marked break from Sir William Beveridge's proposals.

With regard to the self-employed, the difficulties of securing effective control over the payment of benefit are emphasized, as in the Beveridge Report, but the Government proposes to pay benefit to Class II contributors after four instead of after thirteen weeks, and to excuse payment of contributions during those four weeks. An additional allowance of 16*s*. a week will be paid to those on single benefit who have an adult dependant. There will be a standard rate of retirement pension of 35*s*. for a married couple and 20*s*. for a single person. These rates will take effect from the commencement of the scheme instead of starting at 25*s*. and 14*s*., respectively, and increasing to the full rate of 40*s*. and 24*s*. after twenty years as recommended in the Beveridge Report. The pensionable age will be sixty-five for men and sixty for women, but the joint pension will become payable when the husband qualifies, provided that if the wife is less than sixty years old, she is not gainfully occupied. Pensions will be paid only to those who have retired and will be reduced if more than 20*s*. weekly is earned during retirement. They will also depend on contributions paid during the working life of the applicant, and will be reduced when the contribution record shows a deficiency. Pensions will be increased by 2*s*. a week (joint) and 1*s*. (single) for each year of work after retirement age. Special arrangements will be made covering persons already pensioned or insured when the scheme comes into operation.

For married women, additional benefits will be available, subject to certain qualifying conditions, in a maternity grant of £4, maternity benefit at the rate of 36*s*. a week for thirteen weeks for gainfully occupied women, provided that occupation is given up for that period, or for women not eligible for maternity benefit, an attendant's allowance of £1 a week for four weeks. Special provisions will enable married women to insure for a personal retirement pension of 20*s*. a week in lieu of their share in a joint pension, and enabling married women earning more than 20*s*. a week to insure for sickness benefit at the rate of 16*s*. a week and unemployment benefit at 20*s*. a week. The main provisions for widows will be a benefit of 36*s*. a week, with 5*s*. added for the first child, during the first thirteen weeks of widowhood. Thereafter, if there is a dependent child, a guardian's benefit of 24*s*. a week, with 5*s*. added for the first or only child, and a widow's pension of 20*s*. a week to widows who are fifty or over when the husband dies or when the children cease to be dependent, provided ten years have elapsed since the marriage. These benefits will terminate on remarriage, and the last two will be reduced for substantial earnings.

Death grants will be paid at the rates recommended in the Beveridge Report according to the age at death, but an age limit of sixty-five instead of sixty is proposed, when one grant will be paid at the beginning of the scheme, and for persons then between fifty-five and sixty-five the grant will be £10. Such questions as insurance for indirect expenses connected with funerals are reserved for separate examination. Sickness and invalidity benefit, maternity benefit, widow's benefit, guardian's benefit, widow's pension and retirement pension will be reduced by 10*s*. a week during maintenance in hospital after the first twenty-eight days of such maintenance. Not more than any one social insurance benefit or pension will be payable to an individual at any one time.

Apart from the question of workmen's compensation, the Government in its scheme has accepted outright sixteen out of the twenty-three changes proposed in the Beveridge Report; and with modification or reserve two of the others. Essentially the scheme may be described as on a practical basis. The refusal to make disability benefit indefinite in duration or unemployment benefit at full rate indefinite in duration but conditional on attendance at a work or training centre after a limited period, like the rejection of a subsistence basis for benefits, shows that the Government has not adopted the basic philosophy of the Beveridge Report; but there can only be the warmest welcome for proposals which sweep away so many anomalies, and simplify and unify administration and rates of benefit and contribution. It will be noted that the administrative organization outlined is framed to meet the position at the beginning of the new scheme, and that it is proposed to review the position when the scheme is in operation and administrative policy clearly defined and established.

## Industrial Insurance

Whatever slight disappointment may be felt in some quarters with the Government's proposals for social insurance as lacking the boldness of the original Beveridge Report, and keeping more strictly to the

actual abolition of want, no charge of lack of boldness can be brought against the proposals for an industrial injury insurance scheme outlined in the White Paper issued as "Social Insurance. Part 2: Workmen's Compensation"*. The need for radical reform of the present situation is frankly accepted, and the proposals advanced are in some respects an improvement on the Beveridge scheme. They are intended to avoid the main weaknesses and difficulties of the existing system and to remove workmen's compensation from the atmosphere of controversy and conflict with which it has been surrounded and establish it on a happier and sounder foundation.

The White Paper gives first a concise summary of the present system of workmen's compensation in Great Britain, first established in 1897, followed by a survey of the proposals on this question in the Beveridge Report and a concise statement of the Government's views. Generally, the Government endorses the criticisms of the existing system made in that report. In particular, it considers that the Beveridge scheme is too complicated and allows too much scope for contention between the workman (or his trade union) and the employer (or the insurance company or mutual association with which he is insured); it thus tends to retard the workman's recovery and to prejudice good relations between him and his employer. The Government considers it essential to provide that, in future, claims should be made on an independent authority and settled by a procedure less liable to give rise to friction. Accordingly it reaches the general conclusion that the present system should be replaced by a new scheme, the general structure of which should be based on the accepted principles of social insurance.

Proceeding on this basis, the Government agrees with the proposals in the Beveridge Report that the new scheme, broadly speaking, should apply to all persons working under a contract of service, including non-manual workers, and without any income limit; that the cost should be borne by a central fund maintained by contributions from employers and workmen, with a contribution from the Exchequer; that claims should be dealt with by administrative rather than legal procedure; and that the responsibility for the general administration and supervision of the working of the scheme should rest on the authority responsible for the general scheme of social insurance. It is unable, however, to accept four of the main proposals of the Beveridge Report for the reasons indicated below.

First, the Government does not think it right to limit special rates of benefit for long-term disability to cases of more than thirteen weeks duration. Such cases constitute not more than 10 per cent of the total, and the Government thinks the advantage claimed for unification of rates during an initial period is exaggerated. Secondly, the proposal to relate industrial pensions for long-term disability to the earnings of the workman before the accident in cases of total incapacity, and to his earnings both before and after the accident in cases of partial incapacity, is regarded as contravening the principle that there should be differentiation in benefits only according to family responsibilities, and that subject to provision for such responsibilities, there should be uniform flat rates of benefit in return for uniform flat rates of contribution. Further, the assessment of workmen's compensation by reference to earnings has given rise to serious difficulties and objections which are considered in some detail in the White Paper.

The Government therefore proposes to adopt two entirely new features for the assessment of industrial pensions: (*a*) to provide, in accordance with the generally accepted principle of social insurance, uniform flat rates of pension without regard to pre-accident earnings, but taking account of family responsibilities; and (*b*) to give benefit according to the degree of disablement due to the injury in the same way as is done under war pensions schemes, through assessment by a medical board of the condition of the workman resulting from the injury as compared with the condition of a normal healthy person of the same age and sex. This principle has the advantage of getting rid of the distinction hitherto drawn between total and partial incapacity for work, and giving the workman who has suffered an injury causing permanent or prolonged disablement a pension commensurate with the assessed degree of disablement, irrespective of his earning capacity. It eliminates as a cause of dispute the questions whether or to what extent the workman has recovered his earning capacity. It removes the grievance that an improvement in earning capacity results in an automatic reduction of compensation, and avoids any ground for suspicion on the part of the workman that he is being pressed to return to unsuitable work with a view to such reduction, and the fear that if he returns to work he will jeopardize his right to further compensation. It should also remove any hesitation he may feel in submitting to a course of rehabilitation treatment and thus promote a speedier recovery, while it helps to meet the complaint that no compensation is paid for mutilation or disfigurement except in so far as it causes loss of earning capacity.

Thirdly, the Government does not agree with the proposal in the Beveridge Report that special provision in fatal cases resulting from industrial accident or disease should be by way of the grant of a lump sum. Such payments, even if administered under strict control, are not a satisfactory method of assuring an income, and the Government considers that provision for dependants in fatal cases should be by way of pension or weekly allowance. Fourthly, the Government does not accept the proposal that a substantial part of the fund for payment of benefits should be found by means of a special levy on employers in the hazardous industries. This proposal constitutes a departure from the complete pooling of risks adopted generally in other branches of social insurance. "Hazardous industries are not hazardous because employers in them are less active in the prevention of accidents than other employers, or because the workmen in those industries are less careful than other workmen. They are hazardous because of the nature of the employment and the inherent risks." The Government questions the value of the incentive to the prevention of accidents ascribed to the merit rating system suggested in the Beveridge Report, and considers that for further progress in this matter we should look to the development of the standards set up under the factories, mines and other safety enactments, and to the increase of co-operation between employers and workmen. On the other hand, the Government would welcome the establishment of joint bodies for dealing with safety questions—either statutory or voluntary—in all industries where there are substantial risks

* Social Insurance. Part 2: Workmen's Compensation. Proposals for an Industrial Injury Insurance Scheme. (Cmd. 6551.) Pp. 32. (London: H.M. Stationery Office, 1944.) 3*d.* net.

of industrial accident and disease. It also agrees with the recommendation in the Beveridge Report that an inquiry is desirable into the relation, both in industrial and non-industrial cases, between claims to security benefit and claims for damages in respect of personal injury caused by negligence, and also a review of the law governing the liability of employers and third parties to pay damages or compensation to workmen, or their legal representatives and dependants, independently of the provision for them proposed in the new scheme; the Government has set up for this purpose a committee with comprehensive terms of reference under the chairmanship of Sir Walter Monckton.

The remaining features of this new scheme to treat workmen's compensation not as part of the law of employer's liability but as a social service may be briefly summarized as follows. The scheme will be comprehensive, will not provide for 'contracting out' schemes and will apply to accidents arising out of, and in the course of, employment and to specified industrial diseases. The liability, instead of being on the individual employer, will be placed upon a central fund out of which all benefits, both in disablement and fatal cases, and administrative charges will be paid. The fund will be maintained by weekly contributions from employers and workmen collected by stamp, with a contribution from the Exchequer. The weekly rates of contribution will be 6*d*. for adult men and 4*d*. for women, to be shared equally between the employer and workmen, with half these rates for juveniles. Benefits will not depend on a contribution qualification. The scheme will be under the general charge of the Minister of Social Insurance, with an advisory committee or council, on which employers and workmen will be equally represented, to advise the Minister on important matters of policy and administration referred to them. Employers and workmen will be equally represented on the local appeal tribunals.

The present procedure by which the workmen's claims against employers are subject to appeals to courts of law will be superseded by a system under which claims will be dealt with by a pensions-officer, subject to rights of appeal to local tribunals, and further rights of appeal to an industrial injury insurance commissioner whose decision will be final. In disablement cases the benefits will be at uniform flat rates. They will consist of an industrial injury allowance payable for an initial period while the workman is incapacitated for work, to be replaced, where the disablement is likely to be permanent or prolonged, by an industrial pension which will be supplemented by a special allowance if the pensioner is unemployable. Allowances will be given for family responsibilities, and treatment allowances and allowance for constant treatment in certain circumstances. No provision will be made for commutation of the pension by a lump sum payment, but where the injury results in only a minor degree of disability, provision will be made for a final settlement by an award of a gratuity or of a temporary allowance at a special rate with or without a final gratuity. In fatal cases the scheme provides for payment of a pension to the widow with an allowance for the first child, and a higher rate of allowance where the first child is an orphan. Provision will be made, in certain circumstances, for payment of a pension to one or both parents, or where no widow's or parent's pension is payable, to one adult dependent member of the deceased workman's family.

# PROBLEMS OF MODERN PHYSICS*†

By Prof. J. FRENKEL

## The Atomic Nuclei, Elementary Particles and the Nature of Matter

Nuclear physics emerged as a new independent science when, ten years ago, Cockcroft and Walton, working on a suggestion by Rutherford, first used protons artificially accelerated to immense velocities for bombarding other heavier atoms. Before that time, work of this kind had only been done with the help of radioactive substances, atoms of which are transmuted spontaneously without any outside agent, with the expulsion of alpha-particles (that is, helium nuclei) or beta-particles (fast electrons). These alpha- and beta-particles can be used to transmute artificially stable atomic nuclei. This method still has its value, and with its help (by bombarding beryllium with alpha-particles emitted in the natural radioactive disintegration of polonium) it was shown that besides protons (hydrogen nuclei) complex nuclei contain also neutrons. These are particles similar in mass to protons but having no electric charge. To obtain neutrons in the free state, nuclear physics has begun to use clusters of protons or deutons (nuclei of heavy hydrogen). These are accelerated to speeds corresponding to energies of some tens of millions of volts, by special apparatus such as the cyclotron, which was invented in the United States by E. O. Lawrence in 1930.

By such methods it has been possible to cause and study a large number of nuclear reactions of the type

$$A + B \rightarrow C + D,$$

where $A$ and $B$ are the initial nuclei and $C$ and $D$ the resulting ones. These 'alchemical' reactions are in many respects similar to ordinary chemical reactions; but they differ above all in the very much larger energy balance involved (as a matter of fact it is some million times larger). As a rule, one of the reacting particles ($A$ or $B$) is a very simple nucleus, such as a proton or deuton, or in the limiting case a helium nucleus, and the other is a complex nucleus. Thus the reaction $A + B \rightarrow C + D$ is usually treated as the artificial disintegration of the nucleus $A$ by the particle $B$ (a proton, for example), which leads to the expulsion from it of the particle $D$ (say a neutron). Really this reaction results in the union of $A$ and $B$ into a complex nucleus ($AB$), which is in an unstable, excited state, and so spontaneously splits up: $AB \rightarrow C + D$.

Like chemical reactions, these transformations can be either endothermic or exothermic. If $A$ and $B$ have a charge of the same sign, the stage $A + B \rightarrow AB$ requires a definite amount of energy for its initiation, and this is supplied by the kinetic energy of the bombarding particle $B$. This energy is needed to overcome the coulomb repulsion between the two particles. It is as if the nucleus $A$ were surrounded by a protective rampart in the form of a 'potential barrier' of tens of millions of volts, and if the motion of material particles were governed by the classical laws of mechanics then the particle $B$ would have to have kinetic energy at least as great as the height of this potential barrier in order to get past it. In

* Translated by E. R. Holmberg from *Vestnik Acad. Sci., U.S.S.R.*, 4–5 (1943), made available by courtesy of the Science Section of the Society for Cultural Relations with the U.S.S.R.

† Continued from page 421.

actual fact, the penetration of $B$ into $A$ which leads to the formation of a complex nucleus $AB$ is possible when $B$ has appreciably lower energies than this. This is due to a peculiar quantum effect known as the 'tunnel-effect'. However, the probability of this 'tunnel-effect' falls off very rapidly as the kinetic energy of $B$ decreases. For example, if the height of the potential barrier around $A$ is ten million volts and $B$ has a kinetic energy of one million volts, then only one such collision out of about ten thousand will result in $A$ and $B$ uniting. (At very small separations the coulomb repulsion between the nuclei is swamped by a force of attraction of a different kind about which we shall speak later.) So in spite of the tunnel effect, the reaction $A + B \rightarrow AB$ is for practical purposes associated with a definite activation energy; that is to say, the reaction can only take place when $B$ has kinetic energy greater than a definite value.

This position is accentuated when a particle $B$ travels through a solid body composed of atoms of $A$, for $B$ interacts with the electrons surrounding the $A$ nuclei and is thus rapidly slowed down. Since both the nuclei $A$ and the particle $B$ are extremely small, $B$ does not as a rule collide with an $A$ nucleus during the time it has a sufficient energy for an effective collision. As a result, such nuclear reactions occur very rarely, and out of many millions of $B$ particles used to bombard the substance $A$, only one will produce the desired result. So in spite of the fact that in many isothermal nuclear reactions a huge amount of energy is given off per unit weight, the utilization of this source of internal atomic energy is impossible in practice because of the small numbers of the reacting particles. In answer to a question put to him on this subject by a newspaper correspondent four years ago, Einstein said, "It is exactly like throwing bricks at a raven—at night".

The developments of the last two or three years have, however, somewhat shaken this pessimistic point of view, and have once more prompted the hope that the problem of transmuting atoms on an industrial scale can be solved.

If for our bombarding particle $B$ we use an uncharged body, a neutron in fact, then the activation energy becomes zero (because the neutron is not repelled by the nucleus $A$ and can penetrate it with an arbitrarily small initial velocity); and what is more, the neutron does not interact with electrons, behaving among them just as it would in empty space. A free neutron moving through a material body must therefore eventually combine with a nucleus according to the formula $A + B \rightarrow AB$, and its efficiency is 100 per cent. Unfortunately, however, free neutrons are not encountered in Nature (and if they did exist we could not direct their motion). They can only be obtained by excitation of a nucleus by artificially accelerated charged particles, that is, with the help of the reaction $A + B \rightarrow C + D$ (where $B$ denotes a proton, deuton or alpha-particle, and $D$ a neutron) which, as we have just seen, is very inefficient.

In 1939 a new reaction was discovered which involves the division of a nucleus of uranium brought about by slow neutrons. The uranium nucleus is at the limit of stability (on account of its very high electric charge) and divides, under the influence of the shock imparted by the neutron, into two equal parts (rather like a liquid drop which has been highly charged), and these two parts separate with the colossal energy of about 200 million electron volts. From this reaction two or three neutrons are set free with sufficiently high energy to 'explode' other uranium nuclei. Thus the process can, in principle, become like an avalanche. To get this chain reaction, it is necessary first to separate from uranium, which is a mixture of three isotopes, the light isotope with atomic weight 235, which only makes up 0·5 per cent of the total. The trouble is that this light isotope is much more unstable than the ordinary 238 isotope, and tends to disintegrate before it can capture a neutron. This leads almost immediately to a rupture of the neutron 'chain'.

Before the beginning of the War, physicists of all countries were searching for a practical solution of the 'uranium problem', that is, to find a certain way of causing this chain reaction of uranium.

The solution of this problem would open to humanity a completely new technical perspective. It would provide a new source of energy, millions of times more abundant (for equal masses of fuel) than coal or petroleum, although not so widely distributed. There is no doubt that immediately the War has finished, the uranium problem will occupy a central place in experimental and technical physics.

In addition to this there will also be an intensification of the attack on the problem of obtaining charged particles, nuclei of hydrogen and helium, with much larger energies than have been hitherto achieved. In the United States, where at the present time there are eighteen powerful cyclotrons in operation, a gigantic new one was under construction at the beginning of the War, capable of producing charged particles with energies of 100 million volts.

At these energies the efficiency of the nuclear reactions (measured by the ratio of the number of neutrons liberated to the number of charged particles used to produce them) must increase to values many hundreds and perhaps thousands of times greater than those hitherto achieved. If this is so, then the reactions can be carried out on an industrial scale; and besides just utilizing the atomic energy, it may be possible to obtain by transmutation rare and costly elements from those widely distributed in Nature.

The rarest and most costly of all are the radioactive elements—radium, thorium, actinium and the radioactive products of their disintegration. By bombarding normal stable atoms with neutrons, it has been possible to obtain new unstable atoms—radioactive isotopes of practically any element. For this it is necessary to be able to produce a sufficient quantity of free neutrons.

The cyclotrons already in existence provide in a large measure the solution to this part of the problem. With their help it is easy to obtain artificial radioactive elements in quantities equivalent in the intensity of their beta- and gamma-radiation to tens of kilograms of radium. So it is obvious what great value these results have for medicine (some large American hospitals have their own powerful cyclotrons).

These artificial radio-elements have already been widely used as indicators in various physico-chemical and biological investigations (diffusion in solid bodies, assimilation of various substances in living organisms, etc.).

One of the current problems of modern nuclear physics is therefore to increase the efficiency of nuclear reactions by producing particles with energies of tens and hundreds of millions of volts.

The cyclotrons are capable of communicating very high energies to nuclei, but not to electrons. But bombarding nuclei with high-speed electrons with energies around ten million volts appears to be more

direct and effective than using protons, deutons, etc., for producing transmutations of atoms and artificial radio-elements. The first step in this direction has recently been taken, using relatively slow electrons. At the beginning of 1941, Kerst in the United States designed and constructed a simple piece of apparatus which produced a stream of electrons of practically any required energy. The application of these ultra-fast electrons and the ultra-hard gamma-rays they produce, to the transmutation of atoms, will be energetically studied by physicists of all countries as soon as the War ends.

Until now, we have considered the chief problems of nuclear physics from the experimental and engineering points of view. But there are no less alluring and important problems on the theoretical side, and their solution must lead to far-reaching changes in our conceptions of the nature of matter. These new problems arose some ten years ago when the neutron and positron were discovered, and although the respective discoveries of these two particles came independently of each other, they are from the theoretical point of view closely connected.

Until the discovery of the neutron, a complex nucleus was imagined as consisting of protons and electrons (the latter in smaller numbers to give the corresponding positive charge). The existence of electrons in the nucleus was proved, so it seemed, by the fact that the majority of radioactive elements emitted them in the form of beta-rays with an increase of one unit in the positive charge of the nucleus. From the other side, this theory led to a series of unsurmountable difficulties connected with the magnetic and other properties of the nucleus. All these difficulties were overcome when, after the discovery of the neutron, it was shown that it was possible that the nucleus contained no electrons but only protons and neutrons. This, however, raised new difficulties over the question of the production of the electrons which form the beta-rays. The final conclusion is that these beta-rays arise (in the same way as photons when light is emitted) on account of the instantaneous transformation of neutrons into positrons. This bold idea, now firmly established experimentally, was first advanced by D. D. Ivanenko.

From this, of course, it would be imagined that the neutron is not an elementary particle like a proton but something like an atom of hydrogen, consisting of a proton and an electron. This, however, conflicts with the fact, discovered by Joliot in 1934, that certain artificial radioactive nuclei (for example, the one formed by the fusion of aluminium with an alpha-particle) emit positive beta-rays consisting of positive electrons or positrons. Thus the proton can also be regarded as a complex particle made up of a neutron and a positron. Neither of these pictures Is true. Both the proton and the neutron are elementary particles in the sense that neither can be subdivided into still finer particles, although they can change one into another with the simultaneous appearance of an electron or positron. A very convincing argument, based on the law of conservation of energy and momentum, shows that during these transformations certain neutral particles like photons must appear. These have been named the 'neutrino' and 'anti-neutrino'. (In the opinion of some theoretical workers, a photon is equivalent to a pair of these particles.)

Now positrons were discovered by Anderson and Neddermeier completely independently of the neutron, during an investigation of cosmic rays and the influence of magnetic fields on their motion. It was found that a positron came into being with an electron and disappeared in company with another. The energy necessary for the formation of such an electron-positron pair is obtained through the annihilation of a photon; conversely, when a positron-electron pair disappears, one or two photons appear and carry off the energy.

These results, which have been confirmed many times during the past eight years by experiment (it has been found possible to use ordinary gamma-rays and X-rays instead of cosmic rays), have thrown up new fundamental problems for theoretical physics—problems about elementary particles.

In the nineteenth century, the elementary particles appeared to be the atoms. 'Matter', which made up material bodies, was regarded as a collection of immutable atoms of 92 different kinds.

At the beginning of the twentieth century, it was shown that the elementary particles were smaller than atoms, and that the properties of the various kinds of atom were due to the envelope of electrons. The next to be studied was the atomic nucleus, the simplest representative of which is the hydrogen nucleus. It appeared that physics had come to the end of the process of the analysis of matter, having shown that all material particles consisted of protons and electrons, and that all physical and chemical forces (apart from gravity) could be traced to electric forces.

From 1932 onwards, that is, from the moment the neutron was discovered, this simple but incorrect picture underwent enormous conplication. Besides electrons there were positrons, and these and other particles did not appear to be immutable and indestructible but apparently could appear and disappear like quanta of light or photons. If the electrons in the atoms and material bodies appear indestructible, this is only because under normal conditions there are no positrons with which they can unite and so disappear, and also because, generally speaking, changes of protons into neutrons in the nucleus are energetically 'unprofitable' and therefore impossible.

The question arises, Is the indestructibility of protons and neutrons, apart from their mutual interchange, real or only apparent, like that of the electron? A number of demonstrations and experimental facts relating to the behaviour of neutrons and protons tends to show that they are in fact, in every respect except their mass, very similar to electrons. Therefore it seems very probable that, like electrons, they can in favourable circumstances appear and disappear in conjunction with their hypothetical opposites, the antiproton (that is, a proton with negative charge) and the anti-neutron.

If for the birth of an electron-positron pair we need the 'blow' of a particle (say, a photon) with an energy of one million volts, according to Einstein's law (product of mass and the square of the velocity of light) we need for the joint birth of a neutron or proton with its corresponding anti-particle a particle with an energy 2,000 times greater, that is, with an energy of $2 \times 10^9$ volts. At the present time, such particles are found only in the cosmic rays; so it is here that we must look for the phenomenon of the 'materialization' of neutrons and protons. Later on, when physics can produce artificially particles with energies around $10^9$ volts, the process of creating neutrons and protons (together with their opposites) will be controlled just as to-day we can control the creation of electron-positron pairs (by using hard

X-rays). The demonstration and control of these phenomena are the most interesting problems of nuclear physics. Of course, the reality may turn out much more complicated than our scheme based on analogies with proton and neutron on one side and with electrons on the other. The method of analogy is usually limited, but even so it is usually very fruitful (as was shown, for example, in the development of the study of light and matter). It is quite possible, however, that besides neutrons, protons and their antilogues, we shall be able to create particles with mass, magnetic moment and other properties hitherto unknown.

Physics had scarcely recovered from the unexpected appearance of neutrons and positrons when in 1937 Anderson discovered a new type of elementary particle, called the mesotron or meson, in cosmic rays. These particles have the same electric charge as an electron or positron, but their mass is some 200 times greater than that of an electron, that is, about one tenth that of the mass of a neutron or proton. They come into being in the upper layers of the atmosphere as the result of some as yet unknown process of interaction between the primary constituents of cosmic rays (photons, electrons or protons) and atomic nuclei. Their life is only some millionths of a second, yet in this time they are able to pierce the surface of the earth and penetrate to a depth of some hundreds of metres. Finally, the mesons are destroyed by some form of radioactive disintegration into electrons and neutrons.

Apparently the mesons play an essential part in the creation of attractive forces between protons and neutrons at small distances (as, for example, when they are bound together in a complex nucleus). According to a theory put forward in 1936 (that is, before the discovery of the meson) by the Japanese physicist Yukawa, the attraction between neutron and proton can be described as due to a kind of 'ball game' during which fragments are emitted by one particle and absorbed by the other. From considerations of the radius of action of nuclear forces, Yukawa concluded that these fragments should be about 200 times more massive than an electron, and would therefore correspond to mesons. However, the development of Yukawa's theory into a general explanation of nuclear forces has not been completely satisfactory as yet.

The development of physics during the last ten years has given rise to numerous completely new and unexpected problems connected with the nature of matter. The conception that matter consisted of indestructible elementary particles with immutable properties has been shown to be false. True, we have not yet had direct experimental demonstration of the destruction of the heavier elementary particles such as protons and neutrons, but already the one fact of their mutual interchange (in the beta-decay process of radioactive substances) shows that they are no more permanent than electrons. To-day, the problem of matter is concerned not so much with the explanation of the properties of elementary particles as with the explanation of the circumstances of their appearance, disappearance and mutual interchange. There is also the fact that certain particles are not only material objects but also agents of transmission of force between other particles. Thus, for example, photons play the part of transmitters of electro-magnetic forces between charged particles (electrons, protons and mesons), and are tossed across the separating space like balls. As we have seen above, mesons play an analogous part in the transmission of non-electromagnetic 'nuclear' forces between nucleons, as protons and neutrons are called. It is possible that nucleons themselves will be shown to be agents of transmission for as yet unknown forces between unknown particles.

The material world, which a short time ago contained only protons and electrons, is beginning to be occupied by an increasing number of particles of ephemeral existence and the double role of sources and transmitters of force. It is not too much to think that with the use of more powerful sources of energy, physics will be able, starting with known particles such as protons and electrons, to discover or rather create new particles with completely different masses, mechanical and magnetic moments, and electric charges. Some of these will be unstable or radioactive like the meson, while others, like the positron, will be stable in the absence of their anti-particle with which they unite and disappear.

This picture of matter, painted by modern physics, appears fantastic at first sight. Actually it is only unusual in terrestrial conditions. In the interior of stars where temperatures reach millions of degrees centigrade, the picture would be completely normal. To-day it can be taken as established that the source of energy coming from the sun and other stars is a nuclear reaction (probably chiefly the formation of helium from hydrogen). A still more intense stream of energy comes from certain stars during a spontaneous process of explosion, which results in the formation of what is called 'nova'. The metamorphosis of matter which occurs in the interior of these stars leads to the emission of a huge quantity of energy.

Information about these distant cosmic processes comes not only from the rays of visible light emitted by stars, but also from the cosmic rays which traverse the earth's atmosphere and penetrate the earth itself to a depth of some hundreds of metres. At the limit of the earth's atmosphere and in the stratosphere, the cosmic rays consist predominantly of photons and charged particles, electrons, mesons and some protons with energies ranging up to $10^{16}$ volts. The mesons, as also apparently the electrons, arise at the edge of the earth's atmosphere. So the question of the original composition of the cosmic rays remains unanswered, like the question of the origin of these rays. Providing the answers is one of the current problems of modern physics and astrophysics.

The conception that matter consists of elementary particles is one-sided, although practically it is justified under terrestrial conditions with our comparatively meagre sources of energy.

The mutual interaction of material particles can be handled with the help of the concept of the dynamic field. To-day we know three kinds of such fields: gravitational, electromagnetic, and finally the recently discovered and as yet unnamed fields which characterize nuclear forces.

These fields extend continuously throughout all space, concentrating in the neighbourhood of material bodies and particles which give rise to them.

The fields due to separate particles can be combined into a 'resultant'. This raises the question of the action upon an individual particle of its own field, which was first posed by J. J. Thomson in connexion with charged particles. It was shown that to a first approximation the reaction of an electromagnetic field upon the particle producing it was formally identical with the force of inertia. Applying this result to a single electron, Lorentz showed that

the inertia or mass of the electron could be completely attributed to the reaction of its electric field, if the charge was supposed as concentrated in a sphere of radius $10^{-13}$ cm. According to this, the law of motion of an electron turns out to be equivalent to the statement that the electron moves so that the total force on it, as determined by the resultant field, is zero. This 'Lorentz principle' is equivalent to the conservation of energy, momentum and moment of momentum for any system of electrons if we associate these magnitudes not with the electrons themselves but with the electromagnetic fields they produce.

That the concepts of conservation of energy, momentum, and moment of momentum, which arose in the mechanics of moving particles, could be applied to the electromagnetic field, had been realized before Lorentz put forward his theory. It was, however, only after the inertia of the electron had been explained as the result of electromagnetic reaction that its kinetic and potential energy could be treated as the electric and magnetic energy of its field.

In this way the electromagnetic field was shown to be the vehicle of all the mechanical properties (energy, mass, momentum, etc.) which were earlier ascribed to material particles. The particles were thus considered not as sources of fields but as products of them—rather like knots in the lines of force. The question of the force of interaction between these 'knots', like the question of self-reaction, loses its meaning, as the resultant force experienced by each of them is zero. The laws of motion of the particles formed by the field agree completely with the law of conservation of energy and momentum of the field.

The further development of field theory concerns the solution of three types of problems: first, problems of the structure of electrons and the atomic nature of electric charge; secondly, the dynamics of nuclear fields; and thirdly, the quantization of dynamical fields.

The structure of the electron has been tackled hitherto from two angles, one treating it as a point charge and the other as if it had extension. Along both avenues of approach insuperable difficulties have been encountered. These difficulties, as also those connected with the atomic nature of the charge, will probably be solved by a thorough application of quantum theory ideas, but before this is possible we need further development of modern quantum mechanics.

The importance of the dynamics of nuclear fields is due to our ascribing the inertia of nuclear particles to the reaction of their own fields. The attempts which were made earlier to treat the inertia of protons as due to the reaction of their electromagnetic field lost their meaning when the neutron was discovered, for the neutron, even without electric charge, has a mass very close to that of the proton. In a number of papers to-day this non-electromagnetic mass is treated as a magnitude corresponding to some nuclear 'charge' bearing the same relation to the nuclear fields as the electric charge does to the electromagnetic field. The protons and neutrons themselves are thus regarded as 'knots' in a nuclear field, either apart from or in combination with an electromagnetic field.

From this point of view matter is a collection of interpenetrating dynamical fields, electromagnetic and nuclear, with material particles and bodies forming knot points. These points can under certain conditions appear and disappear, although the energy of the field, the momentum and other fundamental properties remain unchanged.

This picture is still only a provisional sketch. In order to complete it we need further development of the ideas of the quantum theory. The essence of this theory is an organic statistical synthesis of continuity and discontinuity. It was first introduced in the studies of the motion of particles and of light, and through the development of the quantum aspect of dynamical fields has helped enormously towards the solution of the problem of matter. As a result, new particles have appeared on the physics scene. These are in addition to those which create, or are created by, the known dynamic fields, and serve as vehicles of interaction between the original particles.

In the case of electromagnetic fields, for example, the sources, or if you like products, of which are electrons, the corresponding quantum particle, the transmitter of electromagnetic action is the photon. In the case of nuclear fields created by protons and neutrons, the corresponding quantum particle is apparently the meson. On the other hand, mesons, like electrons, take part in the creation of the electromagnetic field. This prompts the very natural thought that in a sense all particles are quanta with respect to some other particles. In particular, the electron positron pair could in all probability be treated as quanta of some as yet unknown field, which in its turn is created by other particles, for example, the nucleons. But the nucleons could play the same part in relation to other particles probably as yet undiscovered.

But here we are crossing the boundaries of modern physical science and risk falling into the realm of unscientific phantasy. Nevertheless, recent developments of physics have shown how limited and narrow our previous ideas about the physical world were, so in a survey of the problems of modern physics we need not fear a certain extension of its frontiers, even if it is not yet fully justified.

# VALUE TO THE STUDY OF CHINESE CIVILIZATION OF COLLECTIONS AND MUSEUMS IN BRITAIN

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"AT no period in the history of the world has the attention of civilized nations been so fully directed towards China, its early history and modern position as at the present moment." These words, though true to-day, were in fact written exactly a century ago to preface the catalogue of London's first Chinese Exhibition. It was the enterprise of an American, named Nathan Dunn, who, during twelve years spent in China as a merchant, had collected the 1,341 exhibits, representing, so he claimed, "the Chinese world in miniature". More than fifty thousand persons visited his collection in a pavilion built for it near Hyde Park Corner. Presumably the exhibits were in due course shipped back to their owner in Philadelphia.

The next display of the kind remained in England and so contributed to the beginnings of our Chinese

collections. At the wish of the Prince of Wales, a special invitation to take part in the International Fisheries Exhibition of 1883 had been sent to the Chinese Government, which responded by instructing the Inspectorate-General of Maritime Customs to make the necessary arrangements. The resultant Chinese Court in the Exhibition at South Kensington was a great success, and it continued with additions to do service at two other International Exhibitions, Health and Inventions, held in 1884 and 1885 respectively.

The catalogue of the Chinese part at the Health Exhibition shows that the intention was, like that of Mr. Dunn, to represent the material civilization of everyday China. There were typical living-rooms fully furnished, lay figures dressed in costumes worn by every class, various means of transport including a catafalque, stoves, weapons and a macabre item in an effigy of a dead Buddhist priest undergoing cremation. Thirty Chinese came from China: ten shopkeepers to ply their trade in four well-stocked shops; ten cooks to supply Chinese dishes in the restaurant; six musicians to sing, play and act; a carpenter, a painter and two barbers to exercise their callings in public. As to the shops, the carved fronts for which came from China, one was occupied by a Peking firm of curio dealers, one by a firm from Kiukiang with modern porcelain, one by tobacconists from Hankow, and one by a Canton firm selling miscellaneous fancy goods.

These exhibitions marked a new phase. Since the sixteenth century, when free intercourse by sea began between the Far East and the West, products of Chinese craftsmanship had been imported in profusion. Few houses of the well-to-do in Britain lacked some example, and the strange charm of these things inclined our forefathers to accept unhesitatingly fanciful and Utopian accounts of their place of origin. Indiscriminate admiration for Chinese notions and products, and those supposedly Chinese, was the vogue. Towards the latter part of the eighteenth century fashion changed and intellectual Europe became obsessed with the world of ancient Greece and Rome. In the nineteenth century commerce and other contacts increased our opportunities of knowing the real China, and then we started to explore the field of art and archæology in earnest. The notable collection of Mr. A. W. Franks (afterwards Sir Wollaston Franks), first exhibited in 1876, passed in time to the British Museum and provided the foundation of Chinese ceramic collections there. The exhibition in 1876 was ably described by Mr. Franks in a remarkable catalogue which shows a true scientific spirit. But the greatest advance in such studies was achieved by the numerous writings of Dr. S. W. Bushell, who had the advantage of contact with Chinese scholars while serving as medical officer to the British Legation in Peking during 1868–1899. He it was in 1882 who made a basic contribution to the Victoria and Albert Museum by undertaking to buy for it a number of objects of Chinese craftsmanship, chiefly porcelain. For the same Museum he wrote two volumes of a handbook on "Chinese Art", published in 1904 and 1906, which as to scope and scholarship was a pioneer work and has not yet been bettered in some respects. Another medical man did a like service as to Chinese painting. William Anderson, who had been professor of anatomy and surgery at a college in Tokyo, sold his collection of paintings to the British Museum in 1882. Of these, 114 were Chinese, and they formed a nucleus. Four years later was published his catalogue of Chinese and Japanese paintings in the Museum, the first serious study of the subject in a Western language—again an instance of British initiative.

Such were the signs during the middle nineteenth century of reawakened interest in the material culture of China. In both our great national museums progress was quickened by bequests and the example of private collectors. For example, George Salting allowed for more than twenty years his unrivalled collection of some two thousand pieces of Ch'ing porcelain to be displayed in the Victoria and Albert Museum, and bequeathed it to remain there after his death, which occurred in 1910. Our greatest collector was George Eumorfopoulos. During the first thirty-five years of this century he gathered together with rare enterprise and acumen more than four thousand objects representative of nearly all media of Chinese art and craftsmanship. His collection set a new standard; it was bought for the nation in 1935 and then divided between the British and the Victoria and Albert Museums.

Mention has not yet been made of bronzes, because they scarcely figured at all in the early days. Probably Eumorfopoulos was the first to recognize the significance of ritual bronzes as the chief monuments of ancient Chinese civilization and basic criteria for the beginnings of Chinese art. Even Bushell seems to have been unacquainted with the best archaic bronzes, if one may judge from his writings. Though Eumorfopoulos gradually added many to his collection, no truly representative lot of bronzes had been seen in Great Britain until the great International Exhibition of Chinese Art in London, which during less than four months in 1935–36 attracted nearly half a million visitors. Many considered the bronzes the most illuminating exhibit because of the carefully chosen series of 108 pieces lent by the Chinese Government. Undoubtedly this display, so essential to an understanding of early Chinese culture, created a deep impression and stirred collectors to fresh effort. Quite a number now own notable bronzes: for example, Sir Alan Barlow, Mr. Robert Bruce, Mr. A. E. K. Cull, Sir Herbert Ingram, Sir Neill Malcolm, Mr. H. Oppenheim and Mr. and Mrs. Walter Sedgwick. The Cull Collection, small yet important, may be studied in a published catalogue.

From the first the ceramics have been better represented than any other medium. An attempt at a statistical survey would be wearisome; suffice it to say that almost all museums in Britain have some specimens, but comprehensiveness is approached in none except the British and the Victoria and Albert. The Lady Lever Art Gallery at Port Sunlight has a magnificent range of Ch'ing porcelain and little from other periods. That reflects the prevailing aim of collectors in the last century, who were content with these superb later products. During recent decades the fashion has been to seek the wares of earlier periods, and some remarkable collections are the outcome. Those of Sir Alan Barlow, Mr. and Mrs. Alfred Clark, Sir Percival David and Sir Herbert Ingram should be mentioned. The Clark Collection may be studied from photographs at the Courtauld Institute of Art, and an account of the David Collection has been published. The Ingram Collection is specially strong in Yüeh ware.

In a short article omissions are inevitable. Yet jade must not be left out, since it has always figured prominently in the social and religious life of China. That ardent connoisseur, the late Oscar Raphael,

had a special liking for jade. His fine collection of Chinese antiquities in jade and other media was bequeathed to the British and Fitzwilliam Museums. Numerous jade carvings are among Sir Charles Hardinge's collection of 2,539 small objects made of more than a hundred different materials, the whole affording striking evidence as to Chinese beliefs, customs and handicrafts. Also of ethnological value is the Chinese section in the Wellcome Historical Medical Museum. It contains, besides drugs and acupuncture instruments, very diverse exhibits, including many amulets. The student will find special satisfaction in the Cambridge University Museum of Archæology and Ethnology, because here are weapons, tools, currency and pottery from the earliest times, all arranged in chronological sequence. Finally, a word is due concerning the inscribed bone and tortoise-shell fragments found near An-yang at the end of last century. They put back the limits of authentic history and tell us of Chinese civilization more than three thousand years ago. In all, some 2,820 of these fragments belong to three collections: in the Royal Scottish and British Museums and in the ownership of Mr. L. C. Hopkins, *doyen* of the few Western students of archaic Chinese script.

To sum up: there are public and private collections in Britain rich in objects with æsthetic appeal, but poor in those not classed as 'art' which throw equal light on the history of Chinese civilization. Except in the aforesaid Cambridge Museum, small effort seems to have been made to trace evolutionary sequence in the ordinary things of life. Our collections are much scattered and duplicated; we need a central Chinese Museum.

# NEWS and VIEWS

## Visit of Indian Men of Science

IT is now expected that the distinguished Indian scientific men who will shortly visit Great Britain will arrive about the second week of October. They expect to stay in England for about seven weeks, during which time they will visit important scientific laboratories and industrial, medical and agricultural research institutions in and near London in the Midlands and north of England and elsewhere in the United Kingdom; they will also discuss modern scientific progress with such bodies as the Royal Society, the Department of Scientific and Industrial Research, the Medical Research Council, the Agricultural Research Council and the Radio Board. This visit is a sequel to the visit to India last winter of Prof. A. V. Hill, secretary of the Royal Society. It was then suggested that Indian scientific men should be given an opportunity of coming to the United Kingdom and of establishing closer relations between the many new scientific organizations in India and corresponding organizations here. The proposal was warmly welcomed by H.M. Government and by the Government of India. They will be the guests of His Majesty's Government while they are in Great Britain.

The party will probably consist of the following: Dr. Nazir Ahmad, director of the Cotton Technological Laboratory, Matunga, Bombay; Colonel S. L. Bhatia, deputy director-general of the Indian Medical Service; Sir Shanti S. Bhatnagar, director of scientific and industrial research, India; Sir Jnan Chandra Ghosh, director of the Indian Institute of Science, Bangalore, and president of the National Institute of Sciences of India; Prof. S. K. Mitra, of the University College of Science, Calcutta, chairman of the Radio Committee of the Board of Scientific and Industrial Research; Prof. J. N. Mukherjee, professor of chemistry, University of Calcutta; Prof. Megh Nad Saha, of the University College of Science, Calcutta. Colonel Bhatia's departure from India is expected to be delayed, and he will not join the party until later.

## Professorship of Concrete Technology at the Imperial College, London

A RECENT benefaction from the Cement Makers' Federation has enabled the Imperial College, with the approval of the University of London, to institute in its City and Guilds College a new chair of concrete technology. It may not be possible to appoint a professor until after the termination of war with Germany. The chair will be instituted in the first instance for ten years, and will be attached to the existing Department of Civil Engineering. The duties of the professor will be to provide advanced instruction in the principles and technological application of reinforced concrete, to conduct research in his subject, and to consult with industry regarding the practical experience which it will give to students in training. In order to establish the necessary contact with industry, an advisory committee is contemplated, with appropriate representation of interested bodies, which will report to the governing body of the College. At the end of the ten-year period it will review the working of the scheme and advise as to its continuation or termination. A noteworthy feature of the scheme, which might well be followed as a model in future planning of training for technology, is an arrangement, sponsored by a number of building and civil engineering contractors, whereby bursaries will be made available to students devoting one or two years (after a preliminary study of the basic sciences) to intensive study of concrete technology. It has been agreed that industry looks for graduates broadly trained in the fundamental sciences, but with specialized knowledge superimposed; and that its willingness to provide such bursaries is the best assurance that can be given of its intention to absorb men who have thus committed themselves to a specialized course of training.

## Prof. Frank Allen

Prof. Frank Allen has just retired from the position of head of the Department of Physics, of the University of Manitoba, Winnipeg, Canada, after forty years of service. He is a native of Canterbury, New Brunswick, born on February 6, 1874, and is thus one of the great army of educationists given by the Maritime Provinces of Canada to the West. After graduation from the provincial University of New Brunswick in 1900, he spent four years at Cornell, at a time when the United States physicists were just beginning to realize the importance of their calling. Allen received his Ph.D. degree at Cornell and in the autumn of 1904 entered on his work in Manitoba. He has made an important contribution to physics in Canada. He was elected a fellow of the Royal Society of Canada in 1909 and served as a member of the National

Research Council of Canada from May 1932 until March 1937.

Of his work at Manitoba, Mr. Sidney Smith, who has just retired from the post of president of the University of Manitoba, says: "Dr. Frank Allen was a pioneer and a builder in the first university in Western Canada—the University of Manitoba. Appointed to the staff of that University in 1904, when it became a teaching institution, he founded the Department of Physics, of which for forty years he has been the distinguished head. As a gifted teacher, his record may be read in the careers of generations of students. To the new university he brought an inquiring mind and the spirit of research. He constantly advocated that a university is charged with the responsibility of conserving and transmitting the wisdom and culture of the past and also with the duty of extending the horizons of knowledge. He always considered physics in relation to the other physical sciences and, in fact, as a part of a truly liberal education. Specialization did not narrow his outlook: it broadened his interests and influence".

Prof. Allen's research work has been almost entirely on the rather dim borderland where physics, physiology and psychology, the 'three p's', meet. His first work was on colour vision. His aim was to investigate the nervous actions underlying colour vision and other sensory activities. In his own words, the aim of his work was first to place the sense of colour vision on a foundation of experimentally ascertained physiological principles, and then to establish the fundamental identity of the processes underlying all of the special senses, including vision, hearing, taste and touch. Prof. Allen is now engaged on collecting the results of his life-work; many of his papers have appeared in scientific journals, particularly the *Transactions of the Royal Society of Canada*. Prof. Allen's wife died some years ago, but he has a family of two sons and one daughter—Dr. J. F. Allen, who has just been elected to a fellowship at St. John's College, Cambridge; William Allen, an architect in London (England); and Miss Lillian Allen, on the staff of the University of Manitoba. Prof. Allen's many friends join in wishing him many happy years of useful work.

## Chair of Psychology, Birkbeck College

DR. C. A. MACE, who has been appointed to the chair of psychology at Birkbeck College, University of London, holds the degrees of M.A. Cambridge and D.Litt. London. After leaving Cambridge he was for a time at University College, Nottingham. From there he was appointed lecturer in logic and psychology in the University of St. Andrews. He left Scotland to take up the position of University reader in psychology at Bedford College, London. Dr. Mace has published books and papers in both psychology and philosophy, his best-known work in philosophy being the "Principles of Logic" (1933). In psychology his interests are mainly in social and industrial spheres, and in problems concerning economical methods in learning. In 1935 he published a monograph "Incentives, some Experimental Studies" (Ind. Health Res. Bd. Report No. 72). This was mainly concerned with problems arising in industry owing to variations in the will to work of the employee in contrast to the more usual studies of ability. Dr. Mace has also worked on the fluctuations of interests of college and Workers' Educational Association students over several years, and on the psychological make-up of groups of friends. His latest publication is a paper in the *Sociological Review* on some of the psychological causes of national prejudice. In this paper he makes an important theoretical distinction between stereotypes, or rigid mechanisms of thought, and plastotypes, or more fluid ones. Dr. Mace has always been keenly interested in adult education, so his appointment to Birkbeck College seems a singularly happy choice.

## Book Production

IN connexion with the recent discussion of the shortage of educational and other books (see *Nature*, September 9, p. 319), the following reply given by Mr. Dalton in the House of Commons on September 26 should be noted: "The Minister of Production has agreed, at my request, to increase the allocation of paper to publishers of books as from the end of next month to 42½ per cent of their pre-war usage. I hope that the publishers will do all they can to devote this extra paper to supplying liberated territories, as well as Empire and other oversea markets. The Minister of Production has also increased by more than one third the allocation to my special reserve, and has made a further additional allocation for certain classes of educational books. I am in touch with the Minister of Labour about the supply of labour for printing and binding." The additional allowance of 2½ per cent of publishers' 1938–39 consumption of paper will be welcome; but it is difficult to see how Mr. Dalton's hope that the extra paper should be used to supply liberated territories and overseas markets could be fulfilled. It seems very doubtful if any publisher would be able to differentiate sharply between books for such overseas markets and those for use in Great Britain. In any event, there is a definite shortage of educational and scientific books, which are needed as much at home as abroad. Publishers are well aware of this, and will no doubt do all in their power to overcome it. They will also note Mr. Dalton's remark that he is in touch with the Minister of Labour about the supply of labour in the printing and binding trades. As we have said before, these trades have been stripped of labour, and until more workpeople are made available, full use cannot be made of the additional allocation of paper for the production of educational and other books.

## Practical Limits in Social Reform

BULLETIN No. 5 of the Tory Reform Committee "What Shall We Use for Money ?" is of interest as an attempt to indicate the broad limits of what is politically and economically practicable in the field of social reform. The pamphlet distinguishes between income and outlay of the nation as a whole, and the Exchequer aspect, or that part of the national income which passes through the Revenue and Expenditure of the Exchequer. These aspects are discussed separately, and a survey of post-war national outlay and national income after the War emphasizes that our standard of living will, and always must be, dependent on the maintenance of high productive efficiency. Discussing, in conclusion, finance and politics, the Tory Reform Committee does not believe that the measures of social reform which it has championed are beyond the taxable or economic capacity of the nation to bear, or beyond the willingness of the majority of individuals to provide by personal effort and sacrifice. It is well aware, however, that such

limits exist, and they have for the time being been nearly approached; the Committee urges that the time has come to concentrate upon increasing the national income in the cause of social progress by every means and particularly by increased industrial efficiency. The pamphlet is an honest attempt at clear thinking and is a striking contrast to recent pronouncements regarding the adoption of a forty-hour week, which have omitted all indication of the price which has to be paid for adopting any such objective in our immediate post-war programme.

## Geographical Research in China

AN account of geographic research in China by Prof. Chi-Yun Chang (*Ann. Assoc. Amer. Geog.*, **39**, No. 1, March 1944) contains a record of a great deal of valuable work, much of which, under present conditions, may have escaped notice in Great Britain. Large numbers of topographical maps have been printed recently including a bathyorographical one of the whole of China on a scale of one to three million. A beginning of land utilization maps has been made, and a generalized soil map has been published. The Research Institute of Meteorology of the Chinese Academy has been investigating the problems of winds and rainfall over China with the result that the old conception of the south-east monsoon being chiefly responsible for the rainfall has been displaced in favour of cyclonic influences being mainly responsible: most of the rainfall appears to be associated with cold fronts. In historical and other aspects of human geography research has also been active. The report also notes the development of geographical education, probably temporarily interrupted, the foundation of the Chinese Institute of Geography and a number of geographical periodicals.

## Russian Papers on Pure and Applied Mathematics

A NUMBER of Russian publications containing papers on pure and applied mathematics have been received, and most of them have at least an abstract in English, French, or German. In a few cases the papers are entirely in English. They include numbers of the *Bulletin of the U.S.S.R. Academy of Sciences (Mathematical Series)* (1941–43), the Moscow *Receuil Mathématique* (1942–3), *Applied Mathematics and Mechanics* (1943), *Engineering Review* (1943), and *Comptes Rendus* (1943). It is difficult to describe the mathematical contributions in a limited space; they deal with trigonometrical series, the theory of functions and other topics such as are treated in our own mathematical journals. As regards the engineering papers, attention may be directed particularly to the papers by Glagolev, Popov and Proktor on "The Mechanical Properties of Rubber"; Erokhin, Nikolaeva and Oghibalov on "Dynamic Brittleness of Metals"; Kasparov on "Distribution of Pressure on the Blades of a Hydroturbine" (all in *Eng. Rev.*, **2**; 1943) and to those by Astrov, Levin, Pavlov, and Khristianovitch on "The Design of the Laval Nozzles", Pugachev on "The General Problem of Exterior Ballistics for Aviation Bombs", Četajev on "The Sufficient Conditions of the Stability of a Rotating Motion of a Projectile", Banin on "Approximate Conformal Transformations applied to the Plane-Parallel Flow past an Arbitrary Shape" (all in *App. Math. and Mech.*, **7**; 1943).

## Identification of Timbers

MR. ALEXANDER L. HOWARD'S "Studies of the Identification of Timbers" was reviewed in *Nature* of November 7, 1942. It is interesting now to record the appearance of a supplement containing 153 photomicrographs of different kinds of wood ("Supplement to Studies of the Identification of Timbers." By Alexander L. Howard. Pp. 19. London: Macmillan and Co., Ltd., 1943. 5*s*. net), and one cannot but admire the author's continued enterprise in producing a supplement to a book of this kind in time of war, and promising yet another in the near future. Attention was directed, when reviewing the original volume, to certain features of the book which limit its practical value. Since the supplement has been prepared along precisely the same lines, it will be found to present similar difficulties when used for the practical identification of timbers.

## Announcements

WE regret to announce the death of Sir John Ledingham, C.M.G., F.R.S., formerly director of the Lister Institute, London, on October 4, aged sixty-nine.

THE Council of the Royal Aeronautical Society has awarded the Society's Gold Medal to Air Commodore Frank Whittle, for his work on jet propulsion. This award is the highest the Council can make, and has been made on only seven previous occasions, the recipients being as follows: Wright Brothers (1909), Prof. O. Chanute (1910), Prof. G. H. Bryan and Mr. E. T. Busk (1915), Dr. F. W. Lanchester (1926), Prof. L. Prandtl (1927), Sir Richard Glazebrook (1933) and Senor Juan de la Cierva (posthumously, 1937).

THE following appointments have been made in the University of London: Mr. H. Berry, to be professor of pharmaceutics; Dr. W. H. Linnell, to be professor of pharmaceutical chemistry. Both appointments are tenable at the College of the Pharmaceutical Society.

THE National Council for Mental Health has arranged a course of ten lectures, by various authorities, on "The Psychology of Frustration and Fulfilment in Adult Life". The lectures, which are addressed specially to those with social and educational interests, are being given on Tuesdays at 5.30 p.m. at the Caxton Hall, London, S.W.1, and began on October 3. A parallel course is being given on Wednesdays at 5.30 p.m. at the Friends' Meeting House, Bull Street, Birmingham. Tickets for the course can be obtained, price £1, from the Secretary, National Council for Mental Hygiene, 39 Queen Anne Street, London, W.1, or single tickets, 3*s*. 6*d*., at the door before each lecture.

THE Selection Committee of the Harrison Memorial Fund, consisting of the presidents of the Chemical Society, the Royal Institute of Chemistry, the Society of Chemical Industry and the Pharmaceutical Society, will make an award of the Harrison Memorial Prize in December 1944. The Prize, not exceeding £150, is open to a chemist of either sex, being a natural born British subject and not at the time more than thirty years of age, for original investigations in chemistry carried out and published during the past five years. Further particulars can be obtained from the President, Chemical Society, Burlington House, Piccadilly, W.1. Applications must be received not later than December 1, 1944.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Extraction and Purification of Penicillin

Published methods for the extraction and purification of penicillin[1,2,3] are all based on the observation that penicillin can be extracted by ether, amyl acetate or chloroform from strongly acid aqueous solutions. Considerable losses of the antibacterial substance occur during these operations as penicillin is very rapidly destroyed in acid environment, particularly when shaken with air at room temperature.

A search was made for solvents which would extract penicillin from aqueous solutions at a *p*H not harmful to penicillin. It has been found that a large proportion of the antibacterial substance can be extracted by *n*-butyl alcohol from culture filtrates adjusted to *p*H 6·4, at which penicillin is most stable. When a suitable amount of ammonium sulphate was added to the culture filtrate, penicillin was then almost completely extracted by the butyl alcohol. The addition of ammonium sulphate was also of advantage as it precipitated the greater part of the inactive pigments. Penicillin was brought back into aqueous solution by the addition to the butyl alcohol extract of light petroleum ether and dilute sodium bicarbonate solution. During this procedure further purification of penicillin was effected as some impurities remained in the petroleum ether. The concentrated penicillin solution may be further purified by the usual method (ether extraction).

A typical experiment was as follows: 2,000 ml. of the crude culture fluid was adjusted with phosphoric acid to *p*H 6·4 and 800 gm. of ammonium sulphate was dissolved in it. A precipitate containing inactive proteins and pigments formed and was filtered off. 400 ml. of the filtrate was mixed with an equal volume of *n*-butyl alcohol and extracted by shaking. The same butyl alcohol extract was used for the subsequent extraction of four further 400 ml. portions of the culture fluid. To the strong butyl alcohol extract, 400 ml. in bulk, an equal volume of light petroleum ether was added. From this mixture penicillin was extracted by shaking into 200 ml. of a 2 per cent aqueous solution of sodium bicarbonate. The greater part of penicillin contained in the culture fluid was obtained in this way as an aqueous solution of the sodium salt of penicillin. The remaining penicillin was obtained by a second extraction of the butyl alcohol–petroleum ether mixture with another portion of the sodium bicarbonate solution.

The principal advantages of this method of extraction are: (1) there is no loss of penicillin during extraction as it is extracted at the *p*H point of its greatest stability; (2) the antibacterial substance is almost completely extracted from the culture fluid; and (3) considerable concentration and purification is achieved by the same process. Further advantages of the method are that extraction can be carried out at room temperature and that only relatively small quantities of solvents are required. The procedure is simpler and more efficient than other methods of purification and appears suitable for large-scale purification of penicillin.

I am much indebted to Prof. P. L. Sutherland for his advice and interest throughout the course of this investigation. My thanks are due to Mr. G. Denton for technical assistance.

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1 Clutterbuck, P. W., Lovell, R., and Raistrick, H., *Biochem. J.*, 26, 1907 (1932).

2 Abraham, E. P., Chain, E., Fletcher, C. M., Florey, H. W., Gardner, A. D., Heatley, N. G., and Jennings, M. A., *Lancet*, ii, 177 (1941).

3 Meyer, K., Chaffee, E., Hobby, G. L., Dawson, M. H., Schwenk, E., and Fleischer, G., *Science*, 96, 20 (1942).

## Thiophanone Derivatives

Following the recent papers of P. Karrer *et al.*[1,2,3,4] and the communications of E. R. Buchman and H. Cohen[5], R. B. Woodward and R. H. Eastman[6] and L. C. Cheney and J. R. Piening[7] on the synthesis of thiophanone derivatives, it seems desirable to direct attention to work carried out independently in this laboratory on the same subject.

Our method of preparing thiophanones is substantially the same as that of the above authors, and we have described it in the patent literature[8,9,10]. However, in our experiments on the ring closure of ethyl S-(β-carbethoxyethyl)-thioglycollate under the influence of powdered sodium in benzene, we found that ethyl thiophan-3-one-2-carboxylate always at least predominates, whereas Karrer *et al.*[1] and Buchman and Cohen[5] report the formation of the 4-carboxylate. Our evidence for this assertion is based on the following products obtained from the Dieckmann reaction on: (i) ethyl S-(β-carbethoxyethyl)-thioglycollate, giving a cyclic keto-ester which yielded a crystalline derivative with urea[11], m.pt. 173°; (ii) methyl S-(β-carbethoxyethyl)-thioglycollate, giving a product, with urea derivative, m.pt. 222°; (iii) ethyl S-(β-carbmethoxyethyl)-thioglycollate, giving a product, with urea derivative, m.pt. 173° (admixture with that from (i) showed no depression); and finally (iv) methyl S-(β-carbmethoxyethyl)-thioglycollate, the urea derivative of the product of which melted at 222° and did not depress the melting point of that from (ii) on mixing.

That mixtures do occur was shown by subjecting *n*-butyl S-(β-carbmethoxyethyl)-thioglycollate to the same conditions (namely, powdered sodium in benzene), when *two* products were obtained. The main fraction was *n*-butyl thiophan-3-one-2-carboxylate (found: C, 52·7; H, 7·2; S, 15·6. $C_9H_{14}O_3S$ requires C, 53·4; H, 6·9; S, 15·8 per cent) and gave a derivative with urea, m.pt. 170–172° (found: C, 48·8; H, 6·3; N, 10·7. $C_{10}H_{16}O_3N_2S$ requires C, 49·2; H, 6·6; N, 11·4 per cent). The small low-boiling fraction gave a urea derivative, m.pt. 245°, the analysis of which showed it to be derived from methyl thiophan-3-one-4-carboxylate (found: N, 13·2. $C_7H_{10}O_3N_2S$ requires N, 13·9 per cent).

Although it was possible to introduce a side chain in the 2-position (as would be required to reproduce the β-biotin carbon skeleton) by condensation of the corresponding halogeno-compound with ethyl thiophan-3-one-2-carboxylate in the presence of sodium ethylate[10], nevertheless this method was soon replaced by the more satisfactory one of subjecting esters of the type EtOOC.$CH_2$.$CH_2$.S.CH*R*.COOEt (in

which $R$ is the desired substituent) to the action of powdered sodium in benzene solution. In this case, of course, a non-ambiguous formation of the 4-carboxylate occurs. The product was treated with water at 200°[12] to yield directly the required 2-substituted thiophan-3-one[9].

It is worth recording that we synthesized the α-halogeno pimelic acid[13] required for the preparation of thiophan-3-one-2-valeric acid, by converting ethyl hydrogen pimelate to the corresponding acid chloride, which was brominated to the α-bromo-acid halide, followed by alcohol treatment to yield ethyl α-bromopimelate. We believe this constitutes a simpler process than that of Karrer *et al.*[4] or of Cheney and Piening[7].

Fuller details of this work will be published elsewhere.

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[1] Karrer, P., and Schmid, H., *Helv. Chim. Acta*, 27, 116, 124 (1944).
[2] Schmid, H., *ibid.*, 127.
[3] Karrer, P., Kehrer, F., *ibid.*, 142.
[4] Karrer, P., Keller, R., and Usteri, E., *ibid.*, 237.
[5] Buchman, E. R., and Cohen, H., *J. Amer. Chem. Soc.*, 66, 847 (1944).
[6] Woodward, R. B., and Eastman, R. H., *ibid.*, 849.
[7] Cheney, L. C., and Piening, J. R., *ibid.*, 1040.
[8] B.P., 562,313.
[9] British patent application No. 10983/43.
[10] B.P. 562,314.
[11] Compare Behrend, R., *Ann.*, 229, 10 (1885).
[12] Compare Connor and Adkins, *J. Amer. Chem. Soc.*, 54, 3424 (1932).
[13] British patent application No. 15962/44.
[14] Blaise, E. E., and Koehler, A., *Bull. Soc. Chim.*, [4], 7, 215 (1910).

## Peroxidase Activity of the Thyroid

THE finding of Schachner *et al.*[1] that the *in vitro* formation of diiodotyrosine and thyroxine by thyroid slices, with radioactive iodine, $^{131}I$, as indicator, is inhibited by cyanide, azide, sulphide and carbon monoxide (particularly in the dark) led to an investigation of the occurrence of oxidases in the thyroid. The production of a strong peroxidase reaction and the recent publication of a paper by Dempsey[2] focused attention on this enzyme. Dempsey, using the benzidine histological technique, reported the presence of peroxidase in the follicular cells of the thyroid. He claims that the peroxidase reaction is not due to hæmoglobin, since it was discrete and there was no continuity between erythrocytes and intracellular reacting granules. The cellular peroxidase reaction was found to be inhibited by thiouracil and in much smaller concentration than was necessary to inhibit the hæmoglobin reaction. Owing to the non-specificity of the benzidine reaction and the fact that the high concentration of hydrogen peroxide employed in the histological technique would effectively inhibit true peroxidase, however, this finding requires more careful investigation, because of the obvious implications of the reported inhibition by thiouracil.

Since peroxidase catalyses the liberation of iodine from inorganic iodides by hydrogen peroxide, its presence in the thyroid would serve a useful function. Lipmann[3] found that peroxidase is inhibited by sulphonamides. This, however, is contrary to the finding of Keilin and Mann[4], but these latter workers found peroxidase to be partially inhibited by sodium fluoride, another goitrogenic agent. Westerfeld and Lowe[5] discuss the possibility that the quinol-ether linkage in thyroxine may be formed through a peroxidase condensation. They found a quinol-ether among the oxidation products of *p*-cresol by peroxidase. Keston[6] suggests that the xanthine oxidase system may play a part in biological iodinations, furnishing peroxide essential for peroxidase activity. Employing radioactive iodine, $^{131}I$, and using milk as a source of xanthine oxidase, peroxidase and caseinogen, and adding xanthine as a substrate for the xanthine oxidase, he obtained significant iodination of the caseinogen. This reaction was inhibited by thiourea. Addition of catalase, however, did not affect the iodination.

The existence of peroxidase in animal tissues has been doubted. Bancroft and Elliott[7], however, consider that both spleen and lung probably contain true peroxidases, and Huszak[8] has made the interesting observation that the suprarenal medulla contains an active peroxidase but lacks a cytochrome oxidase system. The demonstration by Altchul, Abrams and Hogness[9] of a peroxidase, 'cytochrome c peroxidase', specific for cytochrome *c* suggests a wider distribution of peroxidase than is usually supposed and also a more important role for hydrogen peroxide in biological oxidations.

In the following experiments, horse thyroids were used, obtained very soon after death, each thyroid weighing approximately 10 gm. In the preliminary experiments, filtered aqueous extracts of very finely minced and ground tissue were used, the thyroid being extracted with five times its weight of water containing chloroform. Such extracts gave a strong peroxidase reaction (*p*-phenylene diamine, benzidine and pyrogallol as substrates) and a catalase reaction.

Peroxidase was determined by the purpurogallin method of Willstäter and Stoll[10] as modified by Elliott and Keilin[11]. This was inhibited to a certain extent by both thiourea and thiouracil as shown in Table 1. The catalase activity was not affected.

TABLE 1. INHIBITION OF HORSE THYROID 'PEROXIDASE' ACTIVITY BY THIOUREA AND THIOURACIL

| Concentration of drug | Percentage inhibition produced by Thiourea | Thiouracil |
|---|---|---|
| 0·08 *M* | 96 | — |
| 0·016 *M* | 55 | 60 |
| 0·0016 *M* | 5 | 5 |

An approximately 80 per cent reduction in peroxidase activity was produced by boiling the extract for five minutes.

In contrast to this order of inhibition produced by thiourea and thiouracil, milk peroxidase, prepared according to Elliott[12], was found to be inhibited to a much greater extent, as shown in Table 2.

TABLE 2. INHIBITION OF MILK PEROXIDASE ACTIVITY BY THIOUREA AND THIOURACIL

| Concentration of drug | Percentage inhibition produced by Thiourea | Thiouracil |
|---|---|---|
| 0·01 *M* | 92 | 95 |
| 0·001 *M* | 70 | 91 |
| 0·0001 *M* | 20 | 79 |
| 0·00001 *M* | 0 | 30 |

This discrepancy in the effective inhibitory concentrations of thiourea and thiouracil in these two systems suggested that there might not be any true peroxidase in thyroid and that peroxidase activity could probably be accounted for entirely by hæmoglobin. The peroxidase activity of horse thyroid was in any event small, having an average purpurogallin number (calculated for the water-extractable enzyme) of $6 \times 10^{-3}$. Moreover, the peroxidase activity of dilute hæmoglobin solutions was found to be inhibited to approximately the same extent as the aqueous thyroid extracts by boiling and by thiourea and thiouracil.

The hæmoglobin content of a thyroid extract was determined by the benzidine method as described by Ashby and Chan[13], and of horse blood diluted to give a solution of the same hæmoglobin content. The peroxidase activity of both diluted blood and of the thyroid extract was determined. In the case of the thyroid extract, the catalase content was first determined by the method of Bancroft and Elliott[7] and extra hydrogen peroxide added so that the same optimal concentration of hydrogen peroxide was available for peroxidase activity for both diluted blood and thyroid extract. The purpurogallin formed was identical in both cases, showing that the peroxidase activity of the thyroid extract (purpurogallin number of $5{\cdot}8 \times 10^{-3}$) can be accounted for completely by its hæmoglobin content. It must be remembered, however, that in the above experiments an aqueous filtrate of thyroid was used. Bancroft and Elliott found that not all the peroxidase of animal tissues is extractable with water and used a glycerol suspension of the tissue for determining peroxidase activity.

To substantiate the above findings, the total peroxidase activity, using Bancroft and Elliott's glycerol extraction procedure, of horse thyroid, perfused with Ringer through the thyroid artery in an isolated neck preparation until almost blood free, was compared with that of the unperfused thyroid from the same horse. The total peroxidase activity was decreased considerably by perfusion, the perfused thyroid having an almost negligible activity, with a purpurogallin number of $1{\cdot}0 \times 10^{-4}$. The peroxidase activity of completely blood-free dog thyroids, pooled from twelve dogs previously bled from the heart, was also found to be small, with a purpurogallin number of $4{\cdot}1 \times 10^{-4}$.

It would appear from these results that the thyroid probably contains no true peroxidase, and that inhibition of the synthesis of thyroxine in the thyroid produced by various goitrogenic agents, including thiourea and thiouracil, cannot be accounted for by inhibition of peroxidase activity. For this reason it is doubtful whether xanthine oxidase participates in thyroxine formation. Moreover, horse thyroid was found to contain none of this enzyme. Bernheim and Bernheim[14] have shown that phenyl thiocarbamide inhibits tyrosinase activity. Using the purpurogallin method of Keilin and Mann[15], polyphenolase of potato was found to be inhibited to a considerable extent by thiourea, potassium thiocyanate and sodium fluoride, but aqueous thyroid extracts were found to contain none or negligible amounts of this enzyme.

Experiments are in progress on the effect of thiourea, thiouracil and other goitrogenic agents on the cytochrome oxidase system. Although Mann and Keilin[16] have shown that sulphonamides do not inhibit cytochrome oxidase activity, it is conceivable that the total concentration of cytochrome oxidase or cytochrome *c* in the thyroid might be diminished by sulphonamides or thiouracil.

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Beckenham, Kent. Aug. 23.

[1] Schachner, H., Franklin, A. L., and Chaikoff, I. L., *J. Biol. Chem.*, **151**, 191 (1943).
[2] Dempsey, E. W., *Endocrinology*, **34**, 27 (1944).
[3] Lipmann, F., *J. Biol. Chem.*, **139**, 977 (1941).
[4] Keilin, D., and Mann, T., *Proc. Roy. Soc.*, B, **122**, 119 (1937).
[5] Westerfeld, W. W., and Lowe, C., *J. Biol. Chem.*, **145**, 463 (1942).
[6] Keston, A. S., *J. Biol. Chem.*, **153**, 335 (1944).
[7] Bancroft, G., and Elliott, K. A. C., *Biochem. J.*, **28**, 1911 (1934).
[8] Huszak, *Biochem. Z.*, **312**, 330 (1942).
[9] Altchul, A. M., Abrams, R., and Hogness, T. R., *J. Biol. Chem.*, **136**, 777 (1940).
[10] Willstäter, R., and Stoll, A., *Ann. chim.*, **416**, 21 (1918).
[11] Elliott, K. A. C., and Keilin, D., *Proc. Roy. Soc.*, B, **114**, 210 (1934).
[12] Elliott, K. A. C., *Biochem. J.*, **26**, 10 (1932).
[13] Ashby, W., and Chan, D. V., *J. Biol. Chem.*, **151**, 515 (1943).
[14] Bernheim, F., and Bernheim, M. L. C., *J. Biol. Chem.*, **142**, 213 (1942).
[15] Keilin, D., and Mann, T., *Proc. Roy. Soc.*, B, **125** (1938).
[16] Mann, T., and Keilin, D., *Nature*, **146**, 164 (1938).

## Mepacrine Derivatives in Urine

IN collaboration with the Army Malaria Research Unit, we have developed a technique for the quantitative separation by chromatographic means of mepacrine from urine and from blood. The separation is effected on alumina and is made visible by the intense fluorescence emitted by acridine derivatives in ultraviolet light. In certain (but not all) specimens of urine from some groups of malarial patients receiving therapeutic courses of mepacrine we have observed that a yellow fluorescent band, not that of mepacrine, can be developed on the chromatogram. This band is not observed on chromatograms of normal urines from patients who have not been dosed with mepacrine. Further, a sample of urine to which an authentic specimen of pure 2-hydroxy-6-chloro-9-amino-acridine had been added gave a chromatogram exhibiting a yellow band identical with that obtained from the urines referred to above. The two bands, the one obtained from malarial urine and the other produced from a urine to which the amino-compound mentioned had been added, exhibited exactly similar behaviour on the alumina columns. Thus neither band could be eluted using methyl or ethyl alcohol, ether, benzene, chloroform, acetone, amyl alcohol, pyridine or even glacial acetic acid, whereas both bands were eluted by *N* hydrochloric acid.

A solution of the new acridine derivative was obtained by extruding the chromatogram developed from urine and extracting the band required with *N* hydrochloric acid. The solution showed the very characteristic change in fluorescent colour from yellow in acid solution to deep orange in alkali at *p*H 10·5, which is characteristic of 2-hydroxy-6-chloro-9-amino-acridine. On mixing the solution obtained from the extracted chromatogram with a solution of the authentic hydroxy-amino-compound, it was found impossible to separate the two components chromatographically.

We think it possible that the fraction *C* isolated from the urine of dogs dosed with mepacrine by Scudi and Jelinck[1], but not identified by them, may be the 2-hydroxy-6-chloro-9-amino-acridine mentioned above.

D. LL. HAMMICK.
D. FIRTH.

Dyson Perrin Laboratory,
Oxford. Aug. 10.

[1] *J. Biol. Chem.*, **152**, 27 (1944).

## Presence of a Labile Toxin in Yolk-Sac Cultures of Rickettsia

GIROUD[1] reported the presence of a specific toxic substance in suspensions of Rickettsia-infected organs which produced dermal lesions in rabbits. Gildenmeister and Haagen[2] found that yolk-sac cultures of Rickettsia are toxic for mice when injected intraperitoneally. We have been studying the nature of the toxin present in yolk-sac cultures of Rickettsia and summarize below some of the observations noted thus far.

Yolk-sacs of infected eggs were removed on the fourth day after inoculation, placed in buffered broth (one part nutrient broth and one part phosphate buffer *p*H 7·4), in the proportion of 1 part sac to 10 parts fluid and shaken in a mechanical shaker for 60 minutes. This process is sufficient to break up the infected cells, the rest of the sac membrane remaining intact, and yields a suspension relatively free from tissue cells and debris. The suspension is then decanted, centrifuged lightly to remove gross debris, and an opalescent fluid rich in Rickettsia obtained.

This suspension of Rickettsia when injected intradermally into rabbits gives on the second or, more usually, third day an indurated, inflamed nodule with a central necrotic area. If the suspension is centrifuged in an angle centrifuge at 4,500–5,000 revolutions for about two hours the supernatant fluid, now practically free of Rickettsia, still gives a typical skin reaction in rabbits even when diluted twenty to forty times. The injection of this supernatant fluid intraperitoneally into mice or rats is followed regularly, on the third to the fifth day, by a considerable enlargement of the spleen and liver without any Rickettsia being found even when murine strains are used. The sedimented Rickettsia resuspended in an equal volume of phosphate buffer (*p*H 7·4) and injected in the same manner give a similar but stronger reaction in rabbits, and in mice and rats Rickettsia can readily be seen in the enlarged spleen. This suspension of Rickettsia still produces a reaction in dilutions of 1 : 80, that is, it is two to four times as toxic as the supernatant fluid. If this suspension of Rickettsial organisms is frozen and thawed seven or eight times, the same reactions are obtained, although no live Rickettsia can be demonstrated either by yolk-sac cultures or by animal inoculations.

It appears, therefore, that the rabbit skin lesion and the splenic enlargement in mice and rats are caused by a toxic substance present in the supernatant fluid freed from Rickettsia, as well as in the organisms themselves. This toxin is present in cultures of both human (louse-borne) and murine (flea-borne) strains of Rickettsia.

This toxic substance, whether in the supernatant fluid or in the organisms, was found to be extremely labile. It was completely inactivated by heating for half an hour at 56–60° C., largely so at 50° C., but not at all at 40° C. The original culture suspensions diluted with an equal volume of distilled water, and kept at 37° C., lost their toxicity partly after two days and completely after three. A reduction in toxic strength occurred also after seven days in the ice box (10–12° C.).

Shaking with ether (Squibb U.S.P. for anæsthesia) for half an hour completely inactivated the toxin both in the supernatant fluid and in the Rickettsial suspension. After complete removal of the ether, no toxic effect resulted from injecting any of the fractions obtained by this treatment.

Rapid freezing and thawing of culture suspensions, seven or eight times, apparently killed the organisms, but the toxic strength of the supernatant fluid obtained after centrifugation in the angle centrifuge was enhanced. Similar treatment of the supernatant fluid, free of Rickettsia, resulted in a reduction of the toxicity. It appears that repeated freezing and thawing is to some extent injurious to the toxin, but that if the treatment is carried out when Rickettsia are present, the injury to the toxin is compensated by fresh toxin liberated from the organisms.

It seems, therefore, that the Rickettsial strains studied contain near the cell surface a toxic substance which is readily liberated into the medium in which they grow or are suspended. This toxin is highly labile, being destroyed at 56° C. in half an hour and at 37° C. in three days. From the point of view of vaccine preparation its inactivation by simple, rather brief, treatment with ether is of particular interest.

Our work has not yet proceeded far enough to indicate whether the toxins produced by the murine and human strains are antigenically distinct. Both produce the same reactions in rabbits, mice and rats, and both are equally labile.

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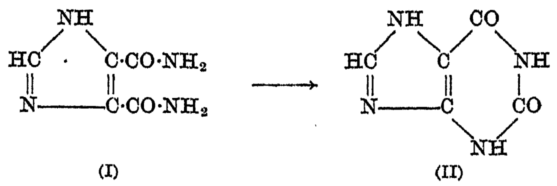
[1] Giroud, P., *C.R. Soc. Biol., Paris*, **127**, 864 (1938).
[2] Gildenmeister, E., and Haagen, E., *Deut. Med. Woch.*, **66**, 979 (1940).

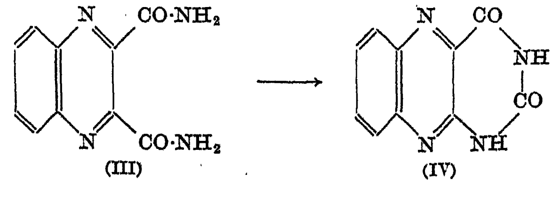
## A New Synthesis of Xanthine

BY the action of alkaline potassium hypobromite on phthalamide, Hoogewerff and van Dorp[1] obtained 2 : 4-dihydroxyquinazoline. Various applications of this intramolecular Hofmann reaction have since been reported; for example, when applied to succinamide, maleamide and pyrazine-2 : 3-dicarboxyamide, the reaction leads to dihydro-uracil[2], uracil[3] and lumazine[4] respectively. We have found that the reaction is applicable to *glyoxaline-4 : 5-dicarboxyamide* (I), which on treatment with alkaline hypobromite solution gives xanthine (II).

The ready availability of the diamide (I) makes this method an attractive synthetic route to xanthine and substituted xanthines. The reaction appears to be of a general nature, and its application to 1-*methyl*-



(I) (II)



(III) (IV)

*glyoxaline*-4 : 5-*dicarboxyamide*, which may yield either 7- or 9-methylxanthine (or, less likely, both) is being examined. In a different connexion, the reaction has been applied to *quinoxaline*-2 : 3-*dicarboxyamide* (III) to give alloxazine (IV) in 60 per cent yield.

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F. S. SPRING.

University, Manchester.

[1] *Rec. trav. Chim.*, **10**, 4 (1891).
[2] Weidel and Roitner, *Monatsh.*, **17**, 174 (1896).
[3] Rinkes, *Rec. trav. Chim.*, **46**, 268 (1927).
[4] Gabriel and Sonn, *Ber.*, **40**, 4857 (1907). Cf. Kuhling, *Ber.*, **28**, 1968 (1895). Kuhn and Cook, *Ber.*, **70**, 761 (1937).

## Loss of Inorganic Constituents on Combustion of Coal and Coke

THE standard method for preparing coal and coke ash for analysis is to burn off the carbonaceous matter by placing the sample in a silica tray contained in a muffle furnace heated to 800° C. While this procedure clearly leads to the volatilization of a proportion of the sulphur, arsenic and other volatile elements, it has hitherto been considered a valid assumption that the whole of the sodium, potassium, calcium, magnesium, silica, iron, alumina and phosphorus contained in the fuel is also present in the ash.

Observations made in the course of an investigation relating to flue solids have led us to suspect the correctness of this assumption.

To decide the issue, coal and coke were fired in a bomb such as is used for calorific-value determinations or heats of combustion. By this method all the inorganic components of a fuel are retained in the bomb. Preliminary experiments indicate that, in the case of sodium or potassium, 0–60 per cent of the original content expressed as percentage of ash may be lost when the ash of a fuel is prepared by combustion in a muffle furnace kept at 800° C. with free access of air. The bomb method of combustion for the concentration of the inorganic constituents of a fuel is a valuable technique which may reveal the presence of unsuspected elements, as well as the fact that certain elements are present in greater proportion than is usually thought. It may also reveal that determinations of elements (for example, phosphorus) by a method which depends upon their concentration in the ash by combustion of the carbonaceous material of a fuel are in error.

A. H. EDWARDS.
A. O. PEARCE.

British Coal Utilisation Research Association,
Coombe Springs, Kingston-on-Thames.
July 28.

## Metabolism of Gill Epithelium of a Freshwater Mussel

GRAY compared (1928) the chemical mechanism underlying rhythmic ciliary movement in mussel gills with that of muscle, especially the frog's heart, and found an essential similarity. Our knowledge of muscle chemistry, especially as regards the carbohydrate catabolism, has since increased considerably, and it appears worth while now to attempt a renewed comparison.

I have studied the epithelium of the gills of the freshwater mussel *Dreissensia*, which will retain its activity and oxygen consumption unaltered for at least 24 hours in ordinary fresh water after being cut off. When the gills are shaken in the Warburg apparatus, many cells will drop off, but even these will remain active.

As a basis for comparison, the nitrogen content has proved more suitable than either wet or dry weight. 13 per cent of the nitrogen found is located in the gill skeleton, the rest in the epithelium, and the gills on the two sides of the animal correspond within 3 per cent. The oxygen consumption per mgm. N/hour at 20° C. is 18·7 µl. and the *R.Q.* 0·87 with a standard deviation of 0·04.

Ciliary movements are inhibited in about an hour by 25 millinormal sodium fluoride and in 45 minutes by 3·3 millinormal monoiodoacetamide, but not at all by phloridzin in concentrated solution. All these determinations were made at 20° and *p*H 7·5–7·6. Complete lack of oxygen stops the cilia in 30 min. at *p*H 6·5, but the effect at *p*H 8·5 is slight only. This agrees with a finding by Clark and Eggleton (1938) that the anaerobic formation of lactic acid in the frog's heart is inhibited at acid reactions.

Tests were made to find out whether lactic acid was formed in the ciliary epithelium under anaerobic conditions at *p*H 8·5, but while a considerable amount of acid was formed, as shown by the liberation of carbon dioxide in the Warburg vessels, the special test for lactic acid (Koenemann, 1940) showed no increase whatever.

An attempt was made to isolate the acid by extraction with ether after precipitation of proteins. It turned out to be volatile and to smell like lower fatty acids, but sufficient material for chemical identification was not obtained.

When the ethereal solution was shaken with normal caustic soda and this afterwards titrated electrometrically with 0·1 *N* hydrochloric acid, the titration curve showed a definite inflexion at *p*H 5, again indicating that the substance differs from lactic acid which shows a *p*K of 3·9.

Lower fatty acids are produced by anaerobiosis in certain animals, notably valerianic acid in *Ascaris* (Weinland, 1901), and several formulæ have been proposed to account for their formation from sugar. These require the simultaneous formation of carbon dioxide, which was observed also in the case of *Ascaris*, but corresponding tests on *Dreissensia* gills gave a negative result. No carbon dioxide was produced anaerobically from half the gills of four animals in 5–7 hours as compared with the other half, determined at the beginning of the period.

On the other hand, it was shown by similar comparisons that glycogen, found to make up about 1·5 per cent of the fresh weight, disappears from the gills both in aerobic and in anaerobic metabolism, but at about three times the rate during anaerobiosis. The glycogen disappearing is only partly catabolized, as reducing substances are found in the medium at the end of the experimental periods.

The respiratory quotient of 0·87 shows that some other substance than carbohydrate must be regularly catabolized, and a definite formation of ammonium proportional to the oxygen consumption was observed.

The experiments are to be continued, but so far as they go they are sufficient to show that the metabolic mechanism supplying energy for the ciliary movements in *Dreissensia* differs definitely from that of muscular contraction in vertebrates.

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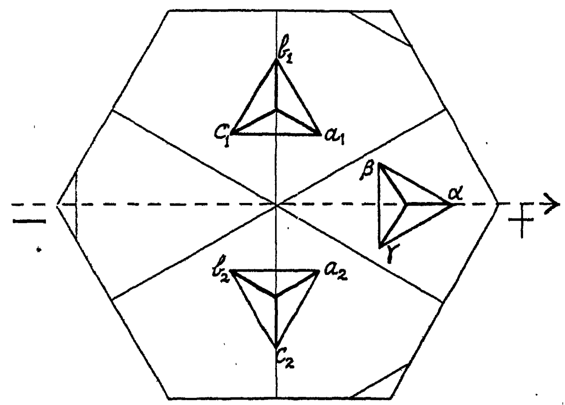
Stockholm. July 30.

## Orientation of the Etching Figures of Quartz

THE etching figures produced on quartz crystal by hydrofluoric acid are different on surfaces cut in different orientations. The case in which the surface is normal to the optic axis is particularly interesting, since with such a surface, the etching pattern obtained consists of a great number of projecting triangular pyramids. This fact, first observed by Leydolt[1], was afterwards studied by Molengraf[2] and more recently by H. Arsandaux[3], Pan Tcheng-Kao[4] and A. de Gramont[5]. It is generally accepted that the three heights of the equilateral triangular base of each pyramid are respectively parallel to the three electric axes of the quartz, and that the three vertices of the base point towards the positive extremities of these axes when the crystal is under compression. A. de Gramont[6] asserted that the parallelism between the orientation of the elementary pyramids and the bisectors of the angles formed by the hexagonal prism of quartz is not always true and that a deviation of a few degrees may sometimes be found. According to this author, the directions of the pyramids and not those of the bisectors represent the true directions of the electric axes of quartz.

In the course of investigating the effect of ultra-violet radiations on the etching figures of quartz, I have carefully compared, by means of a high-precision micrometer, the orientation of these pyramids with the edges of the cross-section of the hexagonal prism. Measurements were performed on a number of plates cut from different crystals of Brazilian quartz. In contradiction to the observations of previous workers, the three basal heights of the pyramids are by no means parallel to the three directions of the bisectors of the angles of the hexagonal cross-section. As a matter of fact, the angle formed by them is 30°, with some possible variations of only a few degrees; in other words, the pyramids are directed to the mechanical axes rather than to the electric axes of quartz. For left-handed quartz, the directions of the three basal heights of a pyramid are orientated clockwise by 30° with reference to the positive extremities of the three compression electric axes, while for the right-handed quartz the orientation is anti-clockwise, as shown diagrammatically in the illustration.




THE REGULAR HEXAGON REPRESENTS A CROSS-SECTION OF THE HEXAGONAL PRISM OF QUARTZ. FOR A LEFT-HANDED CRYSTAL, THE PYRAMIDS OF CORROSION ARE ORIENTED AS $a_1$, $b_1$, $c_1$, AND FOR A RIGHT-HANDED CRYSTAL AS $a_2$, $b_2$, $c_2$. THE PYRAMIDS ARE BY NO MEANS ORIENTED AS $\alpha\beta\gamma$ AS GENERALLY BELIEVED.

A. Langevin[7] has investigated, by the method of etching, the quality of a number of old piezo-electric quartz plates used in the Laboratoire Curie and the École de Physique et Chimie of Paris. He concluded that the plates which gave low values of the piezo-electric constant were due to the existence of electric twinning, which could not be detected by the plate-makers of the past, who used only optical methods for the selection of plates, and that for plates free from this twinning the values of the constant were found to be very consistent, having as a mean $7{\cdot}05 \times 10^{-8}$ C.G.S. unit. In this connexion, it is interesting to mention the result of A. de Gramont[6]. This author, using the same method of selection as Langevin, found $6{\cdot}38 \times 10^{-8}$ C.G.S. unit instead of $7{\cdot}05 \times 10^{-8}$ as the piezo-electric constant of plates of the best quality. This discrepancy is too great to be accounted for by the ordinary experimental error. It may very probably be caused by the difference in the choice of direction of electric axis of the plates used; since for the determination of this axis A. de Gramont relied on the orientation of the elementary pyramids rather than on the geometrical form of quartz.

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* In orthodox romanization, Chung Shêng-Piao.

[1] Leydolt, *Sitz. K. Akad. W. Math. Naturw.*, 59 (1855).
[2] Molengraf, *Z. Kryst. u. Min.*, **14**, 173 (1888).
[3] Arsandaux, H., *Bull. Soc. Franc. Min.*, **51**, 166 (1928).
[4] Pan Tcheng-Kao, *Rev. d'Optique*, **10**, 153 (1931).
[5] de Gramont, A., *Rev. d'Optique*, **10**, 213 (1931).
[6] de Gramont, A., "Recherches sur le Quartz Piezoelectrique", 22, 52 (1935).
[7] Langevin, A., *C.R. Acad. Sci.*, **209**, 627 (1939).

## Collapse of Determinism

MANY readers of *Nature* will have noted with interest Prof. H. T. H. Piaggio's clear and dispassionate article on the "Collapse of Determinism"[1]. Of particular interest is the statement, "But a third interpretation goes so far as to claim that the existence of causality is disproved". This, of course, was the theme of Prof. E. T. Whittaker's Guthrie Lecture[2]. His arguments, however, are open to serious criticism, and there has been a tendency to throw the onus on Von Neumann's mathematical demonstration[3]. This, however, is also under criticism[4] and there are many who, knowing how easily assumptions can lurk in analytical work, refuse to be mathematically bludgeoned. Harm can be done to the reputation of science by any who proclaim as a definite doctrine what is but a tentative effort.

In Prof. Piaggio's last paragraph he remarks, "Some philosopher-physicists welcome these conclusions as giving us a hope of escape from the tyranny of an iron law of causation and assuring freewill to mankind as well as to electrons!" That, of course, is quite true: one all too often hears the view expressed. Nevertheless, to jump to talk of the "freewill of mankind" after having just talked only of electrons, and without noticing that there has been thrown into the equations an entirely unknown function called 'mind', is 'philosophy' of a type which surely even Thomas Aquinas would not have thought worthy of consideration.

Certainly many chapters of our physical knowledge can be neatly summarized in terms of causal laws. Some other chapters can at present best be summarized in quite different ways. Many physicists feel, however, the same dissatisfaction about these methods as the directors of a successful insurance company, run on statistical lines, might feel about their knowledge of the pathology of mortal diseases. In any event it is of very great interest to know if there exists even so much as a single instance where, by common consent, causal explanations can be definitely ruled out. Until then it would appear highly necessary to refrain from imposing our preconceived ideas, whatever these may be.

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[1] *Nature*, **154**, 122 (1944).
[2] *Proc. Phys. Soc.*, **55**, 459 (1943).
[3] "Math. Grundlagen der Quanten-Mechanik" (1932).
[4] *Proc. Phys. Soc.*, **56**, 195 (1944).

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THE views of Prof. West on the interpretation of the Uncertainty Principle are very similar to my own. However, in writing on a controversial subject, I considered it necessary to mention all interpretations given by eminent authorities. In cases where I personally was not convinced of the accuracy of such views, I used the phrase "goes so far as to claim", and when my objection was very strong indeed, used an exclamation mark. Prof. West's list of references will be useful to readers who wish to form their own opinion on a subject of great interest to both science and philosophy.

In conclusion, I wish to put forward a general argument against all supposed demonstrations of an impossibility, such as Von Neumann's. However careful the logic, at best all that has been demonstrated is that the impossibility holds for the problem as formulated. Other lines of approach, not yet considered, may correspond more accurately to the phenomena, and may lead to a positive result.

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Nottingham.

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## A Siderite of the Fourteenth Century

IBN-BATTŪTAH, the famous globe-trotter of the Middle Ages, in his travels from Tangier to China and West Africa (A.D. 1325–54), on reaching Birgi (the ancient Pyrgion in the valley of the Cayster—not far from the old Ephesus in Asia Minor), some time after 1332, was asked by the local sultan if he had ever seen a 'stone' "that had fallen from the sky". When he replied in the negative, the sultan showed him the 'stone' that had fallen some time ago outside the town, and ordered four stone-breakers to strike it vigorously with iron hammers. They did so, but with no effect. It weighed about a hundredweight and was "very hard with a glitter in it"[1]. All this goes to suggest that it must have been a siderite. This fall is not mentioned in the list given in H. H. Nininger's "Our Stone-Pelted Planet"[2].

It is interesting to note that Dr. J. Astapowitsch, of the Sternberg Astronomical Institute of Moscow, in his letter to me dated July 27, 1937 (in response to my request to make inquiries about the sword presented to Tsar Alexander I of Russia by James Sowerby, made from the Cape of Good Hope siderite[3]), wrote to say he could find no trace of this sword; "but among the meteorite collection of the Lomonossow Meteorological Institute there is a yataghan (Turkish sword without cross-piece) about 60 cm. long from an unknown siderite. It belonged formerly (in the 19th century) to a merchant in Siberia".

In all probability this yataghan was made for a later sultan or Mongol chieftain from a siderite that had actually been seen to fall—*perhaps* from this Birgi one when its true nature was revealed. It would be of interest to ascertain the history of this yataghan prior to the nineteenth century. The fact that "Caliphs and Mongol Chiefs had caused swords to be forged from recently fallen meteoric 'stones'" was well known to scientific men like Alexander von Humboldt[4].

Iron meteorites that have been seen to fall are rather rare.

MOHD. A. R. KHAN.

Begumpet,
Deccan.
June 15.

[1] Gibb, H. A. R., "Ibn Battūta's Travels" (London: George Routledge), 134.
[2] Boston and New York: Huffton Mifflin and Co., 1933.
[3] *Phil. Mag.*, **55**, No. 251 (1820); *Nature*, **135**, 39 (1935).
[4] Bonn, Henry G., "Cosmos", vol. 1 (London, 1849), 124.

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## Prof. W. E. H. Berwick

MAY I supplement Prof. Davenport's notice of his predecessor[1] to put on record an important service to mathematics which I was in a position to witness?

About fourteen years ago, Prof. Berwick suggested that the British Association Committee on Mathematical Tables should apply part of a bequest from Lieut.-Colonel Cunningham to the preparation and publication of a table of cycles of reduced ideals in quadratic fields. The computation of such a table is not a matter of pure routine, and could not be attempted by an operator who did not understand what he was doing; a mathematician was wanted. Fortunately, the late Dr. E. L. Ince, just returned to England from Cairo, was free to carry out the work, and he was a skilled computer as well as an exceptionally fine mathematician. The theory of ideals was a new subject to Ince, and Berwick undertook to initiate him. If, characteristically and irritatingly, Berwick underestimated the ease with which a mathematician of Ince's quality could master the elements of the theory, his own labours were the greater. He spared himself no pains, he improvised details of notation and arrangement, and he kept in close touch with the work from start to finish. The table, which appeared in 1934, properly bears Ince's name alone, but it owes a very great deal to Berwick's generous and enthusiastic help.

Stories of Berwick will be told as long as any of his contemporaries are alive to tell them; and we shall not forget that the arrogance of which we are making kindly fun was the arrogance that refused to acknowledge defeat in the presence of overwhelming physical disaster. Many times Berwick fell prone from his great height; not once did he stoop.

E. H. NEVILLE.

The University,
Reading.
Sept. 4.

[1] *Nature*, **154**, 265 (1944).

# GESTURE ORIGIN OF SEMITIC LANGUAGES

By PROF. ALEXANDER JÓHANNESSON
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IN *Nature* of February 5, I gave a summary of my researches regarding the origin of human speech as set out in my book "Um frumtungu Indógermana og frumheimkynni: On the primitive speech of the Indo-European people and their first home" (University Reykjavik, 1943). I tried to prove that the most important class of the 2,200 constructed Indo-European roots could be explained as imitation by the organs of speech of the movements of the hands. As my conclusions agreed with those propounded by Sir Richard Paget in his work "Human Speech" (1930), I published my researches. I have succeeded in adding much new material, not yet published, to my gesture theory. I was interested to see whether my conclusions for the Indo-European languages were confirmed or not in the Semitic group. I therefore undertook an examination of Hebrew (published in June in the Icelandic periodical *Eimreiðin* under the title "Hebrew and Icelandic"). The result was surprising: as many as 60 per cent of the Hebrew roots could be explained by my own rules for the Indo-European languages.

As Pre-Semitic must be a starting point, just as Pre-Indo-European is, I chose those sounds where Hebrew shows no divergence from the Pre-Semitic. I began with *d, t, th* in Hebrew. Roots in Indo-European beginning with dentals show the predominant meaning "to touch, retain, destroy (the first man either pressed his teeth together or let the tip of the tongue rest against them), extend, draw (in this case the tongue has been drawn back from the teeth to the palate)". In Hebrew many roots beginning with dentals signify "to smash, destroy, force": *dabl*, press together; *dbs*, paste together; *dvs*, tread down; *dka*, subdue; *dkh*, smash; *dkk*, break, smash; *dyk*, destroy; *dchq*, press, drive; *dqq*, smash; *tbch*, kill, slaughter; *tby*, press into something; *thphph*, beat the drum; *thqy*, clasp one's hands; *trph*, tear; *thkk*, subdue, smash, break; *thmk*, grasp, hold tight, etc. Many 'dental' roots signify to extend, draw: *dag*, be sad (get contracted); *dgl*, hoist a flag (*l* is the movement of the tongue to the palate); *dvk*, tear away; *djg*, draw up a fish; *dchh*, push (draw away); *tvh*, spin; *tvch*, cover (drag over); *tchh*, throw away; *tchch*, cover; *tyh*, lead astray; *tphch*, get expanded; *trch*, throw burdens on something, etc.

*l* in Ide. signifies especially "to move, withdraw, glide slowly, devour, lick, play, lie without movement". In Hebrew: *lhm*, devour; *lchd*, lick; *lyt*[2], devour eagerly; *lyg*[2], imbibe noisily; *lqq*, lick. Further: *dlg*, spring, play; *dlh*, hang relaxed; *dll*[1], be limp; *dll*[2], be slack, of slowly running water; *dlph*, leak, drip; *tbl*[1], immerse in water; *tla*, put a spot on something; *tll*[2], sprinkle; *thla*, hang up; *thlh*, hang on gallows; *thll*[1], heap up gravel; *thll*[2], betray (play a trick with one). Most Hebrew roots consist of three consonants, and it is clear from these and other examples that it is not always the first consonant that determines the meaning, this depending on the varying emphasis of the sounds.

*r* in Ide. signifies especially "to put in movement, make noise, erect". In Hebrew: *rvd*, roam; *rbk*, stir about; *rgy*[1], be in turbulent movement; *rhh*, be excited; *rkb*, ride. Further: *dbr*, drive; *dhr*, drive (horses); *dvr*, turn round; *dqr*, pierce; *dra*, push away; *drg*, pace, walk; *drr*, run incessantly; *trd*, drive away, etc.

*m* is formed by closure of the lips and should therefore signify "to finish, be silent", or something similar. This meaning appears seldom in Ide. In Hebrew: *dvm*, keep silence; *dmh*[2], be quiet; *dmm*, become silent (from fright); *dmn*, manure (put cover on); *tym*, taste; *thmm*, be perfect, have finished.

Of 138 roots beginning with *d, t, th* in Hebrew, the gestural origin is seen in 51 roots: *l* in the middle or final position decides the meaning in 15 roots; *r* in middle or final position in 11 roots; *m* in the middle or final position in 7 roots. Thus 84 of 138 roots (60 per cent) are evidently gestural.

Similar results are obtained by examining other sounds. The *s* roots in Ide. often signify "to run" (of water or fluid). In Hebrew: *svch*[1], flow away; *svch*[2], sink down or in; *suph*, rush; *svph*, float, swim; *sqq*, sieve (a juice); *svb*, flow, run; *skk*, sink down (of water); *snr*, conduct water; *srh*, be moist.

The relationship between Ide. and Semitic, which has been suggested for hundreds of years, is not accepted by the majority of philologists to-day. The possibility of relationship is not denied (Herm., Hirt and others). If the gesture theory is right, this doubtful question becomes clear. The first Indo-Europeans as well as the first Semitic people began to speak by imitating the signs of the hands with their speech organs. This primitive state of speech shows clearly in many Ide. and Semitic words, which apparently seem to be of the same origin (comp. Herm. Möller's comparative Ide.-Semitic dictionary). A common origin is possible. But if the constructed Pre-Indo-European language is compared with the constructed Pre-Semitic language and the different development of these two groups is kept in mind, a common origin must be at least 10–20,000 years old. A systematic research of all available Semitic material from this new point of view is now needed.

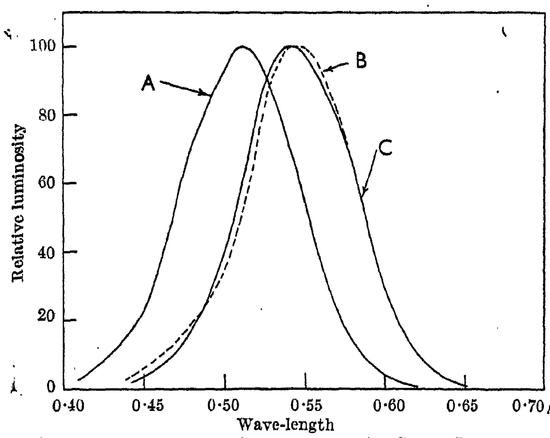
[1],[2] Different meanings of the same root.

# MONOCHROMATISM*

By DR. F. H. G. PITT
Kodak Research Laboratories

MONOCHROMATISM is a type of colour-vision deficiency in which the observer, a monochromat, can match any colour by any other colour, merely by the adjustment of their intensities. It is a very rare form of colour-vision deficiency, its frequency of occurrence in the male population being stated to be so low as 0·0003 per cent[1], as compared with 6 per cent for anomalous trichromatism and 2 per cent for dichromatism. Of this rather tentative 0·0003 per cent, nearly all the recorded cases are monochromats by virtue of their having no cone-vision. Such persons, whose defect is usually described as cone-blindness, rely solely on the functioning of the rods in the retina, and suffer from other ophthalmological defects such as low visual acuity and nystagmus. As might be expected of persons using a mechanism which, in normal persons, only functions when the eyes are dark-adapted, they suffer

* Comm. H982 from the Kodak Research Laboratories, Wealdstone, Harrow, Middlesex.




CURVE $A$, MONOCHROMAT (NO CONE VISION); CURVE $B$, MONOCHROMAT TYPE II; CURVE $C$, $G'$ FUNDAMENTAL SENSATION CURVE.

from photophobia or fear of the light. The luminosity curve for this type of monochromat is shown (Curve $A$) in the accompanying graph[2]. It is very similar to the scotopic luminosity curve for the normal eye. Whether such persons may be classed as colour-blind in the accepted sense of the word is a fine point; if they are accepted as such, then there is no logical reason why totally blind persons should not also be classed in the same way.

Recently, I came across a person who, although a true monochromat, did not suffer from the visual defects associated with the previously mentioned type of monochromat. He had passed the Army visual tests, and a confirming test showed that he had visual acuity well above the normal. His particular duties had proved him to be a very able photometrist. When tested with the Ishihara charts, the American Optical Company's Pseudo-Isochromatic plates, and a test for dichromatism and anomalous trichromatism devised by Mr. R. B. Morris of these Laboratories, he reacted as a typical protanope, and in the first two tests read the letter, which purports to detect the monochromat, with ease. He would have been classed as a protanope had he not casually mentioned that he sometimes had difficulty with the blues. A test on a Donaldson colorimeter showed that he could match any colour with any other colour, thus confirming monochromatism. A further test, performed on special apparatus, also devised by Mr. Morris, showed that his visual recovery curve, after adaptation, was almost identical with that of a normal observer and confirmed what was suspected, namely, that the observer possessed cone-vision.

By kind permission of Dr. W. D. Wright, the full luminosity curve of this observer was measured on the Wright colorimeter[3], which uses a test field subtending an angle of 2°. In the experiment, one half of the field was illuminated by light of wave-length $0 \cdot 53\,\mu$, which could be varied in intensity, and the other half by light of wave-length $\lambda_1$. The observer was asked to match the two colours as accurately as possible for various values of $\lambda_1$, throughout the visible region. This gave Curve $B$, which is similar to the protanopic luminosity curve and accounts for the fact that the observer reacted as a protanope to the three previously mentioned colour-vision tests. Colour matches, made by a normal observer for white and at various wave-lengths throughout the spectral range, were also perfect matches for this monochromat, proving that this form of monochromatism is a reduced form of normal trichromatism.

Although this monochromatic luminosity curve is very similar to the protanopic luminosity curve, it should be noted that the blue ($B'$) fundamental sensation curve[4] modifies the luminosity curve in a minor degree only. The green ($G'$) fundamental sensation curve[4] (Curve $C$) bears a like similarity, and it is therefore concluded that the observer suffers from protanopia, in which the red ($R'$) fundamental sensation curve is missing, and also from tritanopia in which the $B'$ sensation curve is missing[4]. (Judd[1] mentions, without giving any supporting evidence, that a monochromat of this class is born with protanopia and acquires tritanopia later. This acquirement of tritanopia is neither confirmed nor disproved in the case under discussion.) If the conclusion is correct, this form of monochromatism could also be classed as one of double dichromatism, and it follows that, from dichromatic data, we could forecast the possible forms of monochromatism, and, if the dichromatic data were correct, estimate the probability of occurrence. Listed below are the three well-known forms of dichromatism, designated by the names suggested by v. Kries, the reason for the deficiency[4], and the reported occurrence[1]. Another form, called tetartanopia by v. Kries, is suggested by the theories of Hering and Müller, but practical information regarding it is almost non-existent, and what is available suggests that it may be tritanopia recorded on inaccurate apparatus.

TABLE 1.

| Type | Reason for deficiency | Occurrence |
|---|---|---|
| Protanopia | Absence of $R'$ fundamental sensation | 1 per cent |
| Deuteranopia | Fusing of $R'$ and $G'$ fundamental sensations | 1·1 ,, |
| Tritanopia | Absence of $B'$ fundamental sensation | 0·0001 ,, |

From these three forms of dichromatism we obtain the following two possible forms of monochromatism, omitting, of course, the form due to cone-blindness:

TABLE 2.

| Type | Reason for deficiency | Probability of occurrence |
|---|---|---|
| Monochromat I | Absence of $B'$ fundamental sensation accompanied by the fusing of the $R'$ and $G'$ fundamental sensations (tritanopia and deuteranopia) | 0·0000011 per cent |
| Monochromat II | Absence of $R'$ and $B'$ fundamental sensations (protanopia and tritanopia) | 0·000001 ,, |

It is interesting to note that the reason for the deficiency given in Table 1 does not logically permit the occurrence of both protanopia and deuteranopia —if it did it would merely be protanopia. If deuteranopia were not caused by the fusing of the $R'$ and $G'$ sensations, a third class of monochromat would occur, having a probability of occurrence as high as 0·001 per cent, and would undoubtedly have been discovered. The fact that such a discovery has not been made supports the suggested reason for the deficiency, as given in Table 1.

According to Judd (ref. 1, p. 297), the two forms of monochromatism are postulated by one theory only, namely, that due to G. E. Müller, who classifies them as Inner Total Colour Blindness, Type I and

Type II (Type I, as postulated by v. Kries and Hering, being vaguely described as acquired total colour blindness and total colour blindness respectively). As the method of approach followed in this communication is strictly in accordance with the principles laid down by the Young-Helmholtz theory, which in a slightly modified form fully accounts for dichromatism[4], there is no reason why this latter theory should not be extended to cover monochromatism. Type I would be classified as blue-blindness with red and green fusion, Type II as blue and red blindness. Persons having Type I defect would produce a luminosity curve similar to the deuteranopic luminosity curve, but with the relatively small ordinates of the blue luminosity curve subtracted. Such persons have been reported previously, but full luminosity values do not appear to have been measured although the maximum of their luminosity curve is stated to be at $\lambda = 0{\cdot}56\,\mu$, which is in agreement with the above postulate. Persons having Type II defect will produce a luminosity curve as given in the accompanying graph. No other types of monochromat are suggested by any theory or have been reported.

It may be that the recorded occurrence of tritanopia, namely, 0·001 per cent, does not represent the true value, and that this apparently low figure is due in some measure to the fact that the usual forms of colour-vision tests do not adequately cater for this defect. If this is so, the probability of the occurrence of the two forms of monochromatism, namely, one person in every one hundred million, is also too low. Once again the nature of the colour tests normally used would tend to obscure the true figure.


[1] Judd, D. B., *J. Opt. Soc. Amer.*, **33**, 294 (1943).

[2] Wright, W. D., and Granit, R., "On the Correlation of Some Sensory and Physiological Phenomena of Vision". (Published for the *Brit. J. of Ophthalmology, Ltd.*) (George Pulman, London, 1938.)

[3] Wright, W. D., *Trans. Opt. Soc. London*, **29**, 225 (1927).

[4] Pitt, F. H. G., *Proc. Roy. Soc.*, B, **132**, 101 (1944).


# FORTHCOMING EVENTS

### Saturday, October 7

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. A. D. Lacaille: "The Northward March of Palæolithic Man in Britain".

### Monday, October 9

BRITISH MUSEUM (NATURAL HISTORY) (in the Board Room, Cromwell Road, South Kensington, London, S.W.7), at 2.30 p.m.—Dr. J. Ramsbottom: "Edible Fungi".

CHEMICAL SOCIETY (LEEDS AREA LOCAL SECTION) (in the Chemistry Lecture Theatre, The University, Leeds), at 6.30 p.m.—Dr. W. H. Thompson: "Some Trends in Chemical Spectroscopy and the Study of Large Molecules".

### Tuesday, October 10

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Mr. H. N. C. Stevenson: "The Case for Applied Anthropology in the Reconstruction of Burma".

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 5 p.m.—Mr. E. Stroud: Presidential Address.

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield, 1), at 6.30 p.m.—Mr. W. H. Salmon: "The Metallurgist in the Foundry".

### Wednesday, October 11

BRITISH MUSEUM (NATURAL HISTORY) (in the Board Room, Cromwell Road, South Kensington, London, S.W.7), at 2.30 p.m.—Dr. J. Ramsbottom: "Edible Fungi".

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. H. L. Kirke: Inaugural Address as Chairman.

### Thursday, October 12

INSTITUTE OF FUEL (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 2.15 p.m.—Dr. E. W. Smith: Melchett Lecture.

INSTITUTION OF ELECTRICAL ENGINEERS (INSTALLATIONS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. G. O. Watson: Inaugural Address as Chairman.

### Friday, October 13

BRITISH MUSEUM (NATURAL HISTORY) (in the Board Room, Cromwell Road, South Kensington, London, S.W.7), at 2.30 p.m.—Dr. J. Ramsbottom: "Edible Fungi".

(The lecture will be repeated on Mondays, Wednesdays and Fridays until the end of October.)

SOCIETY OF CHEMICAL INDUSTRY (at the Royal Institution, Albemarle Street, London, W.1), at 2.30 p.m.—Prof. A. V. Hill, F.R.S.: "Science in India".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. J. Proudman, F.R.S.: "The Tides of the Atlantic Ocean" (George Darwin Lecture).

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Austrian Centre, 69 Eton Avenue, Hampstead, London, N.W.3), at 6.45 p.m.—Dr. J. Coutts and Dr. Medwei: "Therapeutics in Austria and Great Britain".

INSTITUTE OF PHYSICS (SCOTTISH BRANCH) (in the Natural Philosophy Department, The University, Glasgow), at 7 p.m.—Sir Lawrence Bragg, F.R.S.: "The Physics of the Solid State".

### Saturday, October 14

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at Caxton Hall, Westminster, London, S.W.1), at 2.30 p.m.—Mr. H. Emmett: "Cinemicrography of Crystal Growth"; Mr. R. McV. Weston: "Cinemicrography in Biological Research".

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT ENGINEERS for the British Guiana Government Public Works Department—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.1055.A) (October 9).

TUTOR OR ASSISTANT TUTOR (temporary) IN THE DEPARTMENT OF SOCIAL SCIENCE of the London School of Economics and Political Science—The Acting Secretary, The Hostel, Peterhouse, Cambridge (October 12).

ASSISTANT IN THE MECHANICAL AND ELECTRICAL ENGINEERING DEPARTMENT—The Principal, Harris Institute, Preston (October 12).

SCIENCE LECTURER (full-time) IN THE DEPARTMENT OF BUILDING of the Liverpool Technical College—The Director of Education, 14 Sir Thomas Street, Liverpool, 1 (October 13).

LECTURER (temporary) IN THE SCIENCE DEPARTMENT of the Croydon Polytechnic—The Education Officer, Education Offices, Katharine Street, Croydon (October 13).

ENGINEER (suitably qualified and experienced) for a full-time post in connexion with Production Engineering Courses, and an ENGINEER (suitably qualified and experienced) for a full-time teaching post in connexion with Ordinary National Certificate and Higher National Certificate Courses in part-time day and evening classes, in the Department of Mechanical and Automobile Engineering of Doncaster Technical College—The Chief Education Officer, Education Offices, Doncaster (October 14).

ASSISTANT SPEECH THERAPIST (whole-time)—The Chief Education Officer, 2 Cecil Road, Bristol 8 (October 14).

LECTURESHIP IN THE ENGINEERING DEPARTMENT of the County Technical College, Wednesbury—The Director of Education, County Education Offices, Stafford (October 14).

RESEARCH ASSISTANT IN THE VETERINARY LABORATORY of the AGRICULTURAL DEPARTMENT—The Registrar, King's College, Newcastle-upon-Tyne (October 14).

RESPONSIBLE TEACHER OF ENGINEERING, an ENGINEERING WORKSHOP INSTRUCTOR AND STEWARD, and a TEACHER OF PHYSICS, in the Junior Technical School and in Senior Part-time Classes at the Batley Technical College and School of Art—The Director of Education, Education Offices, Batley, Yorks. (October 16).

CHIEF ENGINEER for the Town Council of New Amsterdam, Berbice, British Guiana—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2296.A) (October 16).

CHEMICAL ENGINEER, experienced in design and installation of chemical manufacturing plant, for supervisory post in London—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2292.XA) (October 16).

HEAD OF THE CHEMISTRY AND APPLIED CHEMISTRY DEPARTMENT—The Principal, Royal Technical College, Peel Park, Salford, 5 (October 16).

LECTURER (full-time) IN CHEMISTRY—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1 (October 16).

ASSISTANT MASTER IN MINING SUBJECTS in the Coalville Mining and Technical College—The Director of Education, County Education Office, Grey Friars, Leicester (October 17).

TEACHER to take charge of BIOLOGY CLASSES and to assist with ELEMENTARY SCIENCE SUBJECTS—The Principal, Harris Institute, Preston (October 18).

PROFESSOR OF PHYSICS—The Registrar, University College, Singleton Park, Swansea (October 18).

ASSISTANT LECTURER IN THE MECHANICAL ENGINEERING DEPARTMENT of the Belfast College of Technology—The Director of Education, Education Office, College of Technology, Belfast (October 30).

CHADDOCK CHAIR OF ECONOMICS—The Registrar, The University, Liverpool (December 29).

LECTURER IN GEOGRAPHY at the Furzedown Training College (evacuated to the University of South Wales, Cardiff)—The Principal, 29 Corbett Road, Cathays Park, Cardiff.

TEACHER (male, Graduate) OF MATHEMATICS with, if possible, subsidiary GEOGRAPHY—The Principal, Technical High School, Cole Street, Scunthorpe.

# NATURE

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CONTENTS



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# FOOD HABITS

IT is no light undertaking to make a scientific study of the food habits of a nation, especially when that nation is at war and is sending vast quantities of its basic foods to its allies in a world which is also at war. The United States Committee on Food Habits is one of two committees set up in 1940 by the National Research Council at the request of the National Defense Advisory Commission, as part of the plan for mobilizing science for defence and war effort. Its report is published under the title, "The Problem of Changing Food Habits"*.

The task of the Committee was to study the psychological and cultural pattern of human nutrition, while the other committee appointed at the same time (the Food and Nutrition Board) had the task of dealing with the biochemical and physiological aspects of this problem. The aim was not merely to tell us why we eat what we do eat, but also to guide the food habits of various kinds of people in the direction required by health and national and world needs. This study requires the consideration of economics, culture, tradition, agriculture, national and individual psychology and other factors which govern the consumption of food by communities or individuals. As the preface to this brochure explains, little had been done when the Committee was appointed to study the relation of culture and behaviour and personal traits to food habits, and it had a pioneer job. It had to collect existing knowledge of what foods were liked and disliked by different kinds of people, to stimulate research and to be ready to advise. Dr. Carl E. Guthe, the chairman, contributes a detailed history of the Committee, and Miss Margaret Mead, the executive secretary, reviews the work done.

One of the Committee's first tasks was to organize the mass of existing knowledge, which ranged from studies of soil agronomy to studies of historically changing diets, the relationship between purchasing power and foods eaten, the relation of learning to eat with other types of learning and such medical data as those supplied by the study of gastro-intestinal diseases and other illnesses which profoundly affect food consumption. At the same time new methods of acquiring further knowledge had to be devised. The study had to be world-wide, and the effects of lend-lease and nutritional relief of other countries had to be included. Gifts of white flour for the relief of famine might, for example, inculcate in a population accustomed to eat whole grains a habit which would have disastrous effects on their health in the future. The way in which foods substituted in war-time for normal ones are presented may affect the post-war acceptance of those foods. The enforcement of nutritional standards may have all kinds of repercussions. The giving of emergency food tickets to children may, for example, break down parental authority, with undesirable results in communities in which this authority is traditionally or culturally strong. The whole cultural picture must be considered

* Bull. National Research Council, No. 108: The Problem of Changing Food Habits. Report of the Committee on Food Habits, 1941–1943. Pp. 177. (Washington, D.C.: National Academy of Sciences, 1943.)

before changes are introduced which may be desirable nutritionally, but may be socially undesirable.

The Committee's method has been to approach the problems largely through the conceptions of cultural anthropology; food habits were seen as "the culturally standardized set of behaviours in regard to food manifested by individuals who have been reared within a given cultural tradition". But these behaviours are related to other standardized behaviours in the same culture. Preference for meat or aversion to milk were not, for example, treated as isolated items, but were referred to the total complex of behaviour which constituted the food habits. Methods of changing food habits are similarly related to psychological factors of learning. The cultured individual reacts both to the food itself and to its production and distribution.

There was no immediate prospect of financing intensive cultural studies of American food habits. Methods for the quick appraisal of some of the more important factors were therefore devised by Prof. Kurt Lewin, of Iowa State University, who contributes an account of the study which he directed by means of a questionnaire addressed to 2,300 Iowa school-children and by interviewing housewives; and Dr. Franklin Dove devised a method of defining the content and pattern of regional food practices. These studies, and others of resistance to change, rationalizations of resistance and so on, have made it possible to identify various social-psychological characteristics of the American food pattern. Examples of these are the tendency, in counties with a Puritan tradition, to use food for purposes of reward and punishment; or the conflict between the emphasis in the southern United States upon personal taste rather than upon health and duty, with consequent catering for the individual tastes of each member of the family; and the emphasis in the north upon "moral overhauling" of the behaviour of each member of the family.

Studies of emergency feeding showed that the most practical way of avoiding giving offence to anyone in a mixed group was to cook single foods with a minimum of seasoning and to serve all condiments separately. The contemporary American cafeteria and methods of self-selection of meals are examples of social institutions well adapted to a variety of incompatible food habits. "The attitude of many European peasants who treat bread as sacred and guard against a single crumb falling on the floor has vanished in a country in which food was the certainty and money the uncertainty"; for, until 1942, very few Americans under forty had had the experience of having money for food while the food was not obtainable. The study of food habits is also necessary for the understanding of subcultural groups in the United States. To this subject Natalie F. Joffe contributes an interesting paper. This aspect must also be studied because the United States will send food to other countries, to the food habits of which these rations must be related.

The study of the number, form and composition of meals reveals some interesting features. A nutritional substitute for meat may, for example, be milk, but culturally the container may have been substituted for the thing contained, so that food which is not nutritionally a substitute for, say, protein, may be accepted if it is put on the table in a casserole or other suitably shaped container. If the shape and size of the container of food is so important to some human beings, they would seem to resemble some animals in this respect, for the farmer knows that he is asking for trouble if he gives his pigs or hens, for example, their food in containers to which they are not accustomed, or if he puts these containers in a new place.

Industrialists will be interested in the section which deals with the effects of altering the time of a meal or of changing the name given to it. Prof. Lewin, discussing this question, claims that people eat according to the clock and that, if they start work at noon, breakfast foods, such as fruit juice, eggs, cereals and milk, may be omitted from the diet. Two other papers also discuss this and other effects conditioned by hours of work.

Prof. Lewin's study further considers the effects of shopping habits, to which must be added the effects of the ration card, the queue and similar factors. If Prof. Lewin's contention is correct that the person who buys the food controls the diet, increased shopping during the War by men or children may affect the content of the meals considerably. In Great Britain this conclusion will, no doubt, be disputed.

Prof. Lewin also provides a discussion of motives for buying different kinds of food, among which, of course, are the amount of money available, the price of foods and the conflicts between these and other economic factors and the ideals of health and cultural tradition. A Czech or an American of Czech origin and a Negro will omit different foods as a result of the conflict between these factors, and there will be similar differences between the decisions of the Jew and the American of German or Anglo-Saxon descent. Meat, concludes Prof. Lewin, is the "most typical husband's food", and this introduces another complication. For whom in the family is the food to be bought? If the husband is a keen gardener, as, for example, the Czech in the United States apparently is, will the family eat more fresh garden produce? If it is true that a man acquires his personal food tastes within the family, he will carry these to public eating places and so affect their catering. But it would be interesting to find out whether this often, or indeed ever, happens in Great Britain; and how much the home catering can be affected by family experience in a public eating house.

Another series of questions arises out of the consideration of the housewife's knowledge of cooking and food values and the degree of her influence on the home. Prof. Lewin suggests as a partial explanation of why we eat what we do eat the "channel theory", which amounts to the self-evident proposition that we do not eat at home what does not come into the home. This forms, nevertheless, the basis of his study of how food comes to the table and why. Prof. Lewin gives paramount importance to the view that once food is on the table, most of it

will be eaten by some of the family. This view also will be challenged by some British authorities. Nor should we forget the importance of the way in which food is served. The effects, for example, of the method of serving it on individual plates are discussed by the Committee on Food Habits, and all of us have probably suffered—or benefited—from the system of training children to eat up what is on the plate, without adequate consideration of what the physiological or mental results may be.

In a leading article in the same issue (p. 47), *The Lancet* gives the salutary reminder that it was not science that made our forbears healthy on the food which they liked; science only enables us to understand why they were healthy. The primary error that we have made, says Mr. F. Le Gros Clark (also in the same issue of *The Lancet*, p. 55), is that of looking upon food habits as a health problem. To the public, milk, for example, is a beverage, and we have almost succeeded in converting it into a medicine. Neither Lord Horder nor Mr. Le Gros Clark is, of course, seeking to belittle the value of scientific knowledge about food; they are both, like the United States Committee on Food Habits and the British Food Education Society, concerned to create a gradual and irreversible change in food preferences; but the views of Lord Horder and Mr. Le Gros Clark will be welcomed for their practical common sense.

The study of the influence of methods of preparation of foods leads the inquirer into many complex problems. *The Lancet* (542, April 22, 1944) has pointed out, in a discussion of a memorandum on hospital diet issued by King Edward's Hospital Fund for London (1943), that the hospital ward offers an unparalleled opportunity of giving people experience of the value of rightly chosen and properly prepared food. The King's Fund memorandum lays down the principle that the food service of a hospital should be one of its essential remedial services; and most of us will agree. The remarkably good recipes for war cookery issued in Great Britain by the Ministry of Food and other agencies during the War have taught the people a great deal about the choice and preparation of meals which are both adequate and appetizing. Lord Horder, in his address to the Food Education Society last June (see *The Lancet*, 53, July 8, 1944), has reminded us that the science of nutrition is a young one and that we should not strain too far the few facts of which we seem certain. Balance the day's diet, by all means, he says, but it is not necessary to balance the individual meal. He also said wise things about white and other kinds of bread.

The many other questions raised by the American report cannot be discussed here. It is already possible, says Miss Mead, to predict the general lines which resistance to, or acceptance of, proposed changes in food habits will follow; but recommendations of methods have to be related to the whole complex of the War and to the cultural, social and individual ideas about food of a variety of peoples. She suggests that, during the War and the immediate post-war period, two tasks must be tackled. One is to maintain the health of the people by the skilful use of existing food supplies; the other is to present the increased knowledge about the use of foods in such a way that it does not become associated with wartime deprivation and therefore is not rejected later on. The additional long-term task, in the United States, is to alter American food habits so that they are based upon a tradition which embodies science and yet are sufficiently flexible to incorporate new scientific results. Altered production and distribution of foods will not by themselves effect this. Nor will authoritative pronouncements effect it, for they tend to breed regional conformity rather than intelligent flexibility. The responsibility rests on those individuals who plan what others will eat. New knowledge must therefore be conveyed to the woman on the farm, in the village and in the city. Mr. Le Gros Clark (*loc. cit.*) would seek the point at which social preferences are most readily influenced, and suggests that the school canteen, aided by committees of parents, could be developed gradually into an institution for the education of public tastes. The pressing need, writes Miss Margaret Mead, is for the integration of the techniques which have been devised for dealing with various aspects of these problems.

## ENGLISH AGRICULTURE, NOW AND AFTERWARDS

(1) The Farm in the Fen
By Alan Bloom. Pp. 192+20 plates. (London: Faber and Faber, Ltd., 1944.) 10*s*. 6*d*. net.

(2) This Farming Business
By Frank Sykes. Pp. 160+8 plates. (London: Faber and Faber, Ltd., 1944.) 8*s*. 6*d*. net.

FORTUNATELY for the countryside of England, there have always been men who have felt the urge to reclaim heaths, moors and wastelands and bring them into agricultural use. Reclamation went on vigorously during the Napoleonic Wars, during the War of 1914–18, and during the present War; it has hitherto been essentially an emergency activity. Unfortunately, a great deal of the land thus brought into cultivation has been allowed to go derelict again, so that the whole of the capital embarked has been lost. Reclamation on the grand scale has been undertaken during the present War and a fascinating account of one of these enterprises has now been published.

Mr. Alan Bloom is a born reclaimer. He began as a nurseryman producing flowering plants for gardens, and having had difficulties owing to dryness of his soil, he looked out for a fen-land farm to which he might transfer the moisture-loving varieties. In 1939 he found a farm in the Burwell Fen which was certainly not short of water; it had, however, been badly run down. Next to it lay Adventurers Fen, which, though at one time cultivated, had long since been abandoned, and had reverted to a water-logged waste. It was a familiar story. Until recently, drainage had been the responsibility of a number of small local bodies, none of them possessing resources or power to do the work properly; as the farms fell in value, so their resources dwindled and less and less drainage could be attempted. Seeing the hopeless-

ness of the situation, some of the owners leased out their land to turf diggers, who left the surface so badly pitted and lowered that any faint chance of restoration to agriculture vanished.

Mr. Bloom was fortunate in beginning work in 1939, when the threat of war compelled the Government to increase the output of food. His financial difficulties disappeared when the War Agricultural Executive Committee not only ensured the proper drainage of his farm of two hundred acres but also appointed him its agent to reclaim another two hundred and eighty-six acres of Adventurers Fen.

Mr. Bloom has a keen sense of detail and describes vividly the draining and the ditching; the work was not without danger, and, indeed, one man lost his life through the caving in of peat and mud, which engulfed him; a horse also was lost and two tractors only narrowly escaped. The removal of the water was followed by the clearing of the scrub growth and by such levelling as was possible. The land was then ready for ploughing, but another difficulty was met: buried in the fen just below the surface were numbers of oaks, ranging up to 50 ft. or more in length, and, of course, very heavy. Much labour and ingenuity were expended in getting these out. Finally the land was sufficiently friable to allow of cultivation.

The crops grown were wheat, sugar beet, potatoes and smaller areas of peas, feeding linseed, buckwheat, etc. Only little grass could be kept for the cattle. The soil lacks phosphate, which so far cannot fully be supplied; it shows signs of manganese deficiency; it would be interesting to know whether there is a copper deficiency as in somewhat similar soils in Holland and North Germany.

In the end a considerable amount of food was produced; it was so badly needed that the cost did not matter. The land, too, is back into proper shape for farming, though, of course, it will always need precautions against weeds, against wind erosion, and against flood and fire. But, as stated above, this kind of thing has been done before. Will Adventurers Fen revert once more to the wild after this War is ended, and the great cost of reclamation simply be lost? The difficulties of keeping reclaimed land in cultivation were ably discussed by Dr. C. S. Orwin some years ago in his account of the reclamation of Exmoor forest. They are great, but they are not insurmountable, and it is devoutly to be hoped that the prodigious amount of labour and money expended in land reclamation during these past few years will not be wasted.

The second book on our list is also a record of splendid achievement in food production, but in very different circumstances. Mr. Sykes, like Mr. Bloom, came new to farming and proved to have a great flair for it. In 1927 he took over the tenancy of 1,200 acres of corn- and downland near Salisbury. Prior to 1914 it had maintained four flocks of sheep and employed a staff of twenty men; then during the War years of 1914–18 there had been much ploughing up and corn growing: the productivity ultimately fell so much that the farm had to be abandoned. Mr. Sykes began by laying it down to grass on which he kept Cheviot ewes and dairy heifers and so was able to make a living for himself and the few men still retained. Later he took another similar farm. By 1935 prices were recovering and he was able to improve his system: he had been impressed by what he had read about the advantages of breaking up and reseeding pastures; he tried the method and found that it succeeded. So he decided to adopt ley farming, and as the natural conditions are suitable he has been able greatly to increase his output of food in consequence.

Mr. Sykes briefly but ably summarizes his methods, and the book is a valuable guide to any young farmer on chalk soils. For seeding the ley he uses a mixture of Aberystwyth rye grass (16 lb. per acre *S*23) and white clover (2 lb. *S*100) on good land, while for poor hill land he adds 5 lb. per acre cocksfoot. He grazes the herbage in the first year and cuts it for hay in the second; he ploughs up directly there is any sign of the appearance of turf. This is done in autumn, and wheat is sown immediately without any break for a bastard fallow, of which he does not approve. A good crop can be obtained relatively cheaply—about £2 per quarter at present prices. But a second crop of wheat on the same land costs much more to produce, and Mr. Sykes brings out clearly the steep rise in cost as the output of wheat is increased. Like many other farmers, he wishes there was a good autumn barley. He has considerable faith in flax, but not much in sugar beet which, in his view, could never stand against sugar cane in free competition. Potatoes he regards as a crop for the specialist, owing to the extent to which it is becoming mechanized; market-garden crops are beginning to interest him, but he prefers to say little about them at present.

Mr. Sykes sets out his views on the future of British farming. The present enormous output of food from our farms is, of course, being achieved regardless of cost: Mr. Sykes states that the only business part of farming now is filling up forms and keeping the Inland Revenue at arm's length. But it will not always be so, and before long the cry will be for cheaper food. Mr. Sykes admits that we could not completely feed ourselves so cheaply as we could import the food, but he thinks that wheat production at some level between pre-war and present output could be maintained at a contract price of 50*s*. per quarter, the wage-rate being as at present. But the British corn-grower cannot stand up against the competition of soil exploiters, or of subsidized imports.

Milk is likely to remain one of the leading farm products, and Mr. Sykes has much to say about its production in greater quantity, in cleaner state, and at lower cost. The present average annual output per cow he puts at 400 gallons, but this could be greatly increased; 1,000 gallons is not an uncommon yield. The trouble is that milk yield is inherited from the sire, and few recorded sires are available. If artificial insemination were adopted much better use could be made of them. He has much to say about the working of the 'clean milk' campaign, tuberculin testing, attested and accredited herds, etc. On individual farms improvement has been effected, but the consumer (who paid the cost) gained little because unclean milk got mixed in during transport. Three diseases, tuberculosis, mastitis and contagious abortion, play havoc with our dairy herds, and he puts the average life of the dairy cow in the milking herd at only two or three years. (The usual figure is higher.) Widespread improvement is difficult because 'reactors' are often sent to market and bought by some other dairy farmer looking for a 'bargain'. One of the great advantages of dairy farming is that it is well suited to the small farmer—and England is and always has been a land of small farms.

Ley farming would also improve our capacity for lamb production, and it should be possible to carry one ewe to the acre. On the other hand, Mr. Sykes

is not sure that our pre-war output of poultry and eggs can be maintained at anything like pre-war prices. The conditions were rather special and may not recur. Our farmers were guaranteed 45*s.* per quarter to produce wheat. But foreign wheat was coming on to the market at much lower rates. Mr. Sykes states that French wheat, for which the French Government had paid the French peasant 60*s.*, was sold in England at 18*s.* per quarter. Much of it was bought by poultry-keepers and converted into cheap eggs. However, with more folding of poultry on the farms, and better arrangements for collecting, grading and storing the eggs, Mr. Sykes thinks that a good and regular supply of poultry products can be assured.

Mr. Sykes is no advocate of self-sufficiency, but he considers that imports should be controlled by an import board. Under this would function production boards for the different farm products on which would be represented producers, retailers and consumers: these boards would fix prices and production levels, improve the quality and the marketing of the products. A national marketing board would correlate their work. He does not, however, wish to see the War Agricultural Committees continue in existence, still less does he want control by officials. The poor farmer must obviously be eliminated, but this will proceed automatically if the production boards insist on adequate standards of quality: to these the poor farmer never could conform.

The book is refreshing and full of good points. A few slips in the chapter on manuring should be corrected if another edition is printed.

A word of praise is due to the publishers, who in spite of war-time difficulties have presented both books in very attractive form and furnished some admirable illustrations. E. John Russell.

## ECONOMIC STUDY OF PLANNING

### The Road to Serfdom

By F. A. Hayek. Pp. viii+184. (London: George Routledge and Sons, Ltd., 1944.) 10*s.* 6*d.* net.

THERE are some who regard this War as liable to become economically a war against the middle class, as indeed the War of 1914–18 was as touching the middle classes in Germany. Even were this the case I do not know that it would greatly awaken my sympathy. By their chauvinistic short-sightedness they have 'asked for' their own extinction. They correspond to the national phase in human development. They made the National State and will perish with it. However, Prof. Hayek undertakes to show us the way by which they and others will travel to that total servile State, which he, along with Dr. Friedmann, sees as the next phase.

Prof. Hayek does an excellent piece of work on the analytical side. Primarily an economic study of what is involved in 'planning for all', it has some of the sombre quality which distinguished Otto von Seeck's great study of 'the rotting away of the best' at the time of the middle Roman Empire. The aristocratic quality of liberty, such as Signor Croce applauds, is at a discount. Prof. Hayek reminds Englishmen of their own distinctive tradition in which they have now lost confidence. He quotes Milton: "They who seek nothing but their own just liberty have always the right to win it". Milton adds, "wherever they have the power". He indicts Profs. Laski, Mannheim and Carr as "the totalitarians in our midst", and he doubtless would add other names such as those of Messrs. Crowther, Haldane, Bernal, Strachey *et al.* Economically Prof. Hayek points out that planning of production means planning of consumption and of "the means of all our ends"; that when a man's life is so planned he loses his economic liberty, not sometimes, as under capitalist unemployment, but always. When material life is controlled, as the Socialists also have said, political liberty is an empty name. John Smith is one forty-millionth of a sovereign and one whole slave. The abstract rule of law departs and the tyrannous 'rule of men', the Hitlerite-Stalinist administrative State, arrives, in which law is subject to considerations of particular effects, *raison d'état* and bureaucratic convenience. Instead of a man planning his own life, it is planned for him (so much more 'efficiently') by the State. He is allocated a 'status', as in the later socialist days of the Roman Empire. As, indeed, Aristotle said was inevitable, "a democracy may set up the most complete despotism imaginable".

Where Prof. Hayek, Dr. Erich Fromm, Peter Drucker and (if I may mention him in the same breath) Prof. Mannheim are weak is on the constructive side. Prof. Hayek agrees with the Marxists that planning must be all or nothing. He therefore wants *laisser-faire* and recognition of "money as one of the greatest instruments of freedom". In Prof. Mannheim's middling position that we can "plan for freedom", he sees only words. I have objected to this Marxist 'die-hardism', and I agree no more with Prof. Hayek or with Mr. Belloc, whom he cites. His is the old argument of Locke (and Hegel) that private property is morally necessary, for those who have got it, as a 'defence of personality'. This is very true but not true enough. Those who control the economic plan can persecute, even to death by starvation—"who does not obey shall not eat"; yet the final liberty remains spiritual and includes the power to refuse co-operation. The point is more than academic. It is being demonstrated by Gandhi to-day, and by the Danes on strike in Copenhagen. It is true that Gandhi only confronts the British Raj, full of Victorian moral inhibitions, and not the tyranny of the modern totalitarian State; but the same methods would probably apply.

The mass of men tolerate more readily death in war than unemployment. There is nothing fine in unemployment. It may well be true, as Dr. Fromm suggests, that the mass of men (perhaps unlike the American pioneers) far prefer security to liberty, of which they are no little afraid. The record of history seems to bear this out. It may be bad for progress that this should be so, but progress was always, as Mill said, of a few. If, however, we decide deliberately to move for a civilization less dominated by large-scale heavy industry and more by peasant farming, then the quite inevitable tendency in machine industry to plan for security will be thrust into a more proper perspective against the freedom of the small owner. The real enemy here lies in war, with its tendency to subordinate all to totalitarian planning, even architecture, even child-bearing. Conversely we discover the imperative necessity for liberty of peace—not this or that political gadget but, as Gandhi has insisted, actual peace—shall we say the flat refusal in the future to fight either the U.S.A. *or* the U.S.S.R.? The Master of Balliol has described the prescription of Prof. Hayek and those who think with him as the certain recipe for revolution. Man,

being made as he is, he is not a liberty lover except in quite small doses. I agree with Dr. Lindsay. But I submit that the Mahatma sees further than either of them. At least the Indian experiment remains one of the few radical ones, that escapes from the compulsions of domination-politics, in our days. I cannot conclude without noting Prof. Hayek's support of that federal union of the whole West, with an Anglo-Saxon nucleus, which I have urged for many years and which now also receives the support of Mr. Walter Lippmann in his "War Aims".

GEORGE CATLIN.

# CERAMICS AS INSULATING MATERIALS

**Porcelain and other Ceramic Insulating Materials**
By Dr. Ernst Rosenthal. Vol. 1: Raw Materials, Manufacturing Processes, Testing and Characteristics. Pp. xii+287. (London: Chapman and Hall, Ltd., 1944.) 28*s*. net.

THE pottery industry is almost virgin territory for the worker in applied science. Despite the trails blazed by J. W. Mellor in Great Britain and H. Seger in Germany, there are still wide tracts quite unexplored. There is still no institution of university status in Great Britain offering a full-time course in ceramics, and the number of qualified chemists and physicists engaged in the pottery industry together scarcely exceeds a baker's dozen. Things seem to be somewhat better in the United States, and there is a number of universities and State colleges at which full-time courses may be followed and degrees obtained in ceramics, usually in the engineering department. Faced with this position, the prospective writer of a book dealing with the scientific and technical aspects of the manufacture and applications of pottery must choose between two alternatives: either he writes for the ceramist and accepts the joy of writing as his main recompense, or he seeks to write a popular work, broadening the range and almost inevitably lowering the level. Dr. Rosenthal has neatly avoided this dilemma by writing a book on ceramics, not primarily for the potter, but for the much more ubiquitous engineer.

The book constitutes a remarkable *tour de force* for a man of science writing in an adopted tongue. Comparatively little trace of foreign terms remains, though the absence of hyphens causes the phrase "felspar containing steatite" to mean just the opposite of what the author intends it to convey, and the extension of this form to "each clay substance containing material" is likely to bewilder the average English reader until he has had time to sort it out. These constructions and some mistranslations, such as precipitation for sediment, subsequent for consecutive, compressor for press, feldspatic for felspathic, and talcum (though not invariably) for talc, might well have been eliminated by more conscientious proof-reading. A few misspellings have crept in by the same door, though "vacuum plugging" is obviously an invention of the printer's devil.

Where numerical data are given, the author has apparently taken over without conversion the units adopted in the original publication, thus compelling the reader to do a fair amount of mental arithmetic if he wishes to compare the figures given in different tables. Still more disturbing to the pedant will be the scant attention which has been paid to uniformity and accuracy in the dimensions of physical quantities. Impact strength appears at least once as cm. per kg., while in the footnote to a table of tensile strengths we learn that 100 lb. per in.$^2$=70·3 gm. per cm. or 7·03 kgm. per cm.$^2$. Power factor is stated to be expressed as $\cos\delta=\sin\delta$ (though given correctly later), and phase angle between current and voltage as 90 per cent. We are informed that thermal conductivity of ceramic materials is usually expressed in K. cal. per m.$^2$ h. °C. on the Continent, and in Cal. per sec. per cm.$^2$ per °C. in American literature; but the variants K. cal. per m.$^2$ per h. °C. and Watts Cm.$^{-1}$ (deg. Cent.)$^{-1}$ also occur in the book.

The statement that slop stone at 26 oz. per pint contains 18·33 lb. stone per peck is an obvious arithmetical slip, but the Brongniart formula looks strange with the plus and multiplication signs interposed. As the whole basis of body compounding by the wet method depends on an accurate knowledge of specific gravity (pint weight) one surmises that the slip maker whose pint measure held *approximately* 20 oz. would soon be parting with his can or his job. The mineralogist will be surprised to read that calcium carbonate occurs in Nature as whiting. Flint as a general term for silica is American rather than British practice. Photomicrographs are mostly called microphotographs in the book—a common error.

All too frequent blemishes of the type indicated above should not blind the reader to the merits of the book; it contains too much of value to be lightly dismissed. The author's wide experience both as investigator and manufacturer invests what he has to say with authority, and the persistent reader will be well rewarded for his pains. Chemical and physical formulæ have been reduced to a minimum. The engineer with even a smattering of chemistry will find no insurmountable barriers, while at least 75 per cent of the book will be comprehensible to 95 per cent of potters. Every pottery manufacturer interested in vitreous bodies or tunnel oven firing, to mention only two 'actualities', would be well advised to read it. There are few ready-made recipes for bodies or glazes, and no specification of the ideal tunnel oven, but much thought-provoking discussion of principles and practice.

Each material has its own characteristic limitations and possibilities which, in turn, influence design. The engineer who thinks that ceramic products might provide the answer to some of his problems should consult the ceramist at an early stage in development. In this connexion the sections dealing with shaping methods and tolerances will be of interest. Though not stated explicitly, the book is primarily addressed to electrical engineers. It can, however, be heartily recommended to engineers in general (the chemical engineer is apparently to be catered for in a subsequent volume), many of whom would probably be surprised to see the numerous photographs of ceramic products in the book—some small and complicated, others large and evidently extremely robust.

In the preface to his book Dr. Rosenthal expresses the view that ceramics could further advance industrial progress if their excellent technical characteristics were more generally known. Is it too much to hope that this view will be shared by those responsible for rebuilding and rehousing schemes?

MARCUS FRANCIS.

# LITERATURE AND SCIENCE

## Science and Criticism

The Humanistic Tradition in Contemporary Thought. By Herbert J. Muller. (Dwight Harrington Terry Foundation: Lectures on Religion in the Light of Science and Philosophy.) Pp. xiv+303. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1943.) 25s. net.

PROF. MULLER, who is a professor of English, is perturbed at the incoherence and lack of standards in modern literature and modern life; as well he may be. He here expounds and criticizes (with good knowledge, sound sense and a pretty wit) many recent scientific theories in all branches, apparently because he thinks a better knowledge of them would improve literary standards. It is almost as though he thought "Macbeth" would be improved by substituting three psycho-analysts for the witches, or "Paradise Lost" by introducing Einstein's theory and the expanding universe.

Perhaps this is a parody of Prof. Muller's intentions. He says himself that he has tried "to make really available, for the purposes of literary criticism, the revolutionary findings in the natural and social sciences, with which critics are generally familiar but of which they make only superficial, incidental or erratic use". If this means anything it can be applied to a concrete case. From the preface to Shaw's "Doctor's Dilemma" it can be seen that his knowledge of medical science is less than superficial because he misconceives the whole character of scientific investigation. Nevertheless the play portrays excellently the contrasts between the medical humbug, the surgical 'go-getter' and two types of honest medical man. Shaw is a good enough observer to reproduce the general flavour of current medical jargon and that was all the technical knowledge he needed. Could any amount of medical knowledge have made any appreciable improvement? As to literary criticism, do critics differ in their judgment of this play according to the extent of their medical knowledge? Surely the knowledge Shaw chiefly needed was of the difference between an honest man and a humbug; knowledge outside the scope of science. It is remarkable that the feeblest character in the "Doctor's Dilemma" is the young artist, who is just stock stage property.

Prof. Muller has been strongly influenced by the philosophy of Dewey and shares his robust good sense, proper suspicion of high-flown theory and respect for the factual and concrete. But even more than Dewey he is shaky on fundamentals. Though he has acute criticisms to make of some recent advocates of 'scientific humanism', he seems to share their inability to distinguish between matters of fact and standards or criteria of value. In literary criticism he obviously has standards which are not those of the average man or the majority, nor are they just expressions of private likes and dislikes. He gives no account of his own standards, but it is clear (pp. 1, 47 note, 283 and elsewhere) that for him they are absolute. Yet, when it comes to other people's absolutes and standards, he takes a severely 'relativist' and 'naturalist' view, urging that every judgment is relative to a particular concrete situation, that nothing has value except to some individual who values it, that it is difficult to define standards of value, perhaps impossible. All these assertions are correct; but if they suffice to demolish other people's standards they demolish his own. Confusion about standards seems to be the key to the writing of this book. The author sees that literary judgments are too often based on caprice or convention or defiance of convention that is equally conventional; that literary standards are hard to discover and impossible to define. Science, on the other hand, seems to possess its own standards, definite and easily understood. Therefore if only the literary man could borrow scientific standards all would be well.

Literary men may learn from this book that if they ride scientific hobby-horses they do so at their own risk, but scarcely anything else. Men of science may benefit by learning what an intelligent, critical outsider thinks of some of their activities. Those who theorize in the realm of the social sciences may benefit by some wholesome criticism.

A. D. RITCHIE.

# A TEXT-BOOK OF ZOOLOGY

## Thomson's Outlines of Zoology

Revised by Prof. James Ritchie. Ninth edition. Pp. xii+1021. (London: Oxford University Press, 1944.) 28s. net.

THE ninth edition of the "Outlines of Zoology" appears after a lapse of fifteen years, and is the first since Sir Arthur Thomson's death. In the preface, Prof. James Ritchie expresses his appreciation of the opportunity afforded to him of paying a tribute to his former teacher "by endeavouring to prolong the usefulness of his widely known Outlines". He was assisted by Dr. Gresson and Mr. G. F. Friend.

In considering a new edition, as opposed to a new book, three questions confront the reviewer. Does the new edition preserve the original character of the book? Have the emendations been fitted into the whole so that the balance has been preserved and overburdening of the text avoided? Has the subject-matter been brought up to date? The outstanding feature of Sir Arthur Thomson's book was that the blending of animal structure and function with a broader 'natural history' made the book readable, and presented the subject to the student so pleasantly that it encouraged him to explore both the main site and the nooks and corners of this vast field of study. Prof. Ritchie has preserved and improved this feature and his re-arrangements do not disturb the flow of thought. His emendations and additions concern chiefly the portions on cytology, histology, embryology and palæontology, while nearly a hundred new drawings, lettered with complete words instead of abbreviations, have been inserted, or used to replace earlier figures. All this has been done without disturbance of the balance of the book.

The cytology section has been modernized; but is it not generally recognized to-day that the chromosomes persist through the resting stage of the nucleus? In the short portions of chapters devoted to embryology more recent work and better figures might have been utilized; for example, Conklin's researches on the origin and development of the mesoderm in Branchiostoma, and the interpretation of cinematograph studies of the primitive streak area in the chick.

On the whole, however, the new edition can be regarded as a most successful effort. Its bulk has been increased only slightly by the addition of about fifty pages, but the price has risen considerably. Despite the latter drawback, the book remains a rich source of information, and should prove useful to many generations of students.

N. B. EALES.

# MEDICAL RESEARCH COUNCIL UNIT FOR APPLIED PSYCHOLOGY

By DR. K. J. W. CRAIK
Director of the Unit

THE Medical Research Council Unit for Applied Psychology consists at present of eleven research workers who had previously been carrying out investigations in the Psychological Laboratory, Cambridge, principally on problems arising from the War, under the direction of Prof. F. C. Bartlett, who continues to have general supervision of the Unit. Of these, six are graduates in psychology, four in medicine and one in physiology. Until the end of the War it is likely that work of the type now in hand will continue. This has necessarily involved problems largely of an *ad hoc* character, undertaken in response to requests from Service departments, but certain common principles have emerged, which may assist in guiding a fruitful approach to future and peace-time problems. These principles are that of suiting the job to the man, of suiting the man to the job, and of improving the man's performance.

The first involves mainly the design of instruments, machinery, lay-out and illumination of maps, panels, etc. These problems may be broadly divided into those of *display* and *control*. The first term is that used by Service scientific departments to cover the methods by which information is laid visually before any operator, whether on a map, a graph, a cathode-ray tube or an instrument panel. Often the best type of display is a compromise, for example, between an instrument-panel so complex that its interpretation is slow or so simple that it gives insufficient information, or, in the case of a night-fighter aircraft panel, so brightly lit that it dazzles the pilot or so dim that it cannot be read. Psychological experiments, employing laboratory simulations of the real conditions, often enable the optimum type of display to be decided upon. Even where an optimum does not exist, a graph of the relation between, say, the distance of a plotter from a map and his accuracy in reading grid references will show a very steep rise in error beyond a certain point, and thus indicate a definite practical limit to the viewing distance, as in certain work by Dr. H. N. Mackworth. There should be a great deal of scope for such work in peace-time industrial design, especially in ensuring easier operation and preventing accidents, for example, in instrument panels, indicators, information charts and graphs. General principles have emerged which narrow the field for *ad hoc* experiments. Exact methods of scoring efficiency in war-tasks, such as watch-keeping, which are of a boring but responsible nature, have shown ways of determining optimal spells of work. The effect of discomfort, fatigue and noise on such tasks is also being studied. These techniques for the measurement of human abilities may eventually provide useful ways of assessing the progress of patients recovering from physical or mental illness, and perhaps may also test innovations introduced by researches in preventive medicine.

On the motor side, the positions, forces and gear-ratios of handles and levers on guns and machine-tools are usually compromises between the factors of speed and precision of operation, of simplicity and mechanical perfection or of psychological and physiological suitability. Here, again, particular cases are being dealt with by laboratory simulations with exact scoring of performance, and interesting principles of muscular action and sensory – motor co-ordination are emerging. These studies verge on physiology and preventive medicine.

Similar problems arise in industrial design (such as the handwheels on a machine-tool, the stage at which servo-motor or remote control becomes necessary, and the most suitable form for such control), while general principles of use to designers in less important cases could be formulated.

Any human act can be regarded as the result of a sensory – mental – motor chain of events, and hitherto those in the Unit who have worked on the above problems have concentrated rather on the sensory and motor ends of this chain, partly because of their individual aptitudes but partly, perhaps, because these are the most fruitful sites for instrumental modification. There is probably, however, an interesting future field in the analysis of the factors that make a task intellectually difficult and have led industrialists to division of labour, with its advantages of increased output and its disadvantages of boredom and discontent.

This approach—suiting the job to the man—should, we feel, be explored to the full, since it puts the industrial jobs necessary for improved standards of living within the power of the majority, whereas psychological selection alone, especially when the job has been made unnecessarily difficult, may result in a high rate of rejection and unemployment. There is, however, need for *allocation* of the available workers so that they are given tasks for which they are suited, and some selection where a task is unavoidably difficult.

This second approach—suiting the man to the job—is principally being tackled by a team under Dr. A. W. Heim. They are members of the Unit, but are working on behalf of the Industrial Health Research Board of the Medical Research Council. They have devised a battery of tests and standardized it on a large number of entrants to factories and Government training centres and some university undergraduates, and are obtaining follow-ups on the industrial subjects. This battery contains a paper test (*AH*4) consisting of a verbal and arithmetical, and a visual part based on relations of identity and opposition, analogy, completing series, and following instructions; a mechanical ability test, an inspection test consisting of metal blocks containing small defects, performance being scored on an accuracy index, speed also being recorded; some other performance tests resembling factory gauging and assembly tasks, and the National Institute of Industrial Psychology Form Relations test. The emphasis of such work must necessarily be on individual differences in ability, rather than on the features of a task which make it difficult to everyone. Research is being carried out on consistency and validity of test results and of assessments, and on the relation between these two criteria. The extent to which the value of a test depends on its degree of analogousness and the distinction between differences of *grade* and *type* of ability are also being studied.

Certain members of the Unit are investigating night vision and other tests from the point of view of selection and of diagnosing vitamin-deficiency and disease. It is hoped that there will also be some time for fundamental work on the special senses. Mr. E. Farmer has begun a study of the capacities of blinded Service personnel with the view of their obtaining suitable employment. Others are using methods which link almost equally with both the two

main approaches discussed above. For example, Miss M. D. Vernon is working on visual form perception and memory with the view both of lay-out of visual tasks and the allocation of personnel, and Dr. D. R. Davis is investigating the sensory motor co-ordination and responses of temperamentally different types of people in controlling machinery.

The third main approach is to improve the performance of the man, either by nutritional means or by mental and physical training. This, again, involves exactly controlled experimental tests of sensory and motor efficiency and scoring of performance. Various synthetic training devices have also been produced for Service use. Similar devices may well have a peace-time application, for example, to motor-car driving or machine-tool operation, where the novice is apt to injure either himself or the machine and to gain little insight into what he is doing wrong. Synthetic training equipment with exact scoring devices can assist here; but psychological experiments should always be undertaken to see whether any given trainer is in fact saving training time and improving performance, and whether it would do so equally well if it were simplified, or very much better if it were slightly complicated.

All these lines of approach involve much statistical work—for example, to establish the significance of the optimum values found for some feature of instrument design and to reveal the consistency or inconsistency of an allocation test, and its validity as judged by follow-up evidence. Though most of the members do the simpler statistical treatment of their own results, Mr. E. G. Chambers and Mr. J. W. Whitfield help in applying more complicated methods and in the development of new ones. Mr. Whitfield is also instituting a new type of recording system in a group of coal mines and two factories with the view of tracing causes of absenteeism, sickness and accidents. Such investigations indicate where there is a definite field for experimental research into improved equipment or for re-allocation or re-training of accident-prone workers.

It is hoped that there will be close contact with other bodies undertaking similar work—for example, the National Institute of Industrial Psychology—and with personnel managers, safety-officers and medical officers in factories. It must be emphasized, however, that the Unit is primarily a research body and has not the personnel or time for investigations of purely specific and local interest. Thus Dr. Heim has introduced, in several factories for which she has worked, a scheme by which members of her team inspect the problem and decide what existing test would seem appropriate and develop new ones if necessary; the firm then provides a suitable person who is trained for a fortnight or so at Cambridge, and returns to the firm to give the tests and forward the results at intervals to Cambridge. Similarly, it will be impossible to take on a large number of particular problems in display or control design; but wherever a problem of wide interest arises, or one involving test-methods which could be applied as routine elsewhere when once they have been developed, the Unit is very anxious to be of assistance to any firms who raise them; and it is hoped that similar work may continue for the Services in regard to their more fundamental problems. The essential thing is that the scientific abilities of the members for basic research which ought, sooner or later, to have its effect on particular problems, should not be swamped by work of transitory and local value.

# MODELS OF THE UNIVERSE AND COSMOLOGICAL TIME-SCALES

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THE two time-scales, one 'dynamical' and the other 'cosmological', introduced by Prof. E. A. Milne into his theory of the structure of the universe, have certain curious biological consequences pointed out in *Nature* by Prof. J. B. S. Haldane[1]. Another time-scale has just been put forward by Sir Arthur Eddington[2] on the basis of his unification of general relativity and quantum theory. It is therefore an opportune moment to attempt a general survey of cosmological investigations and, in particular, to direct attention to the very special assumptions on which the results of such inquiries depend. I do not believe that it is possible to give an accurate account of cosmological theory without expressing oneself to some extent in mathematical terms, and I trust that the reader will forgive this necessary evil—if evil it is.

## Models of the Universe

Cosmological theories, whether connected with general, or with Milne's kinematical, relativity, start from the conception of an ideal universe which we shall call a 'model of the universe'. Essentially this may be regarded as a geometrical model in which the observed aggregate of spiral nebulæ is idealized into a set of mathematical points tracing out certain curves called 'geodesics' in a 4-dimensional space-time. This space-time possesses a 'metric' of the general form

$$ds^2 = dt^2 - e^{g(t)}\left\{\frac{dr^2}{1-kr^2/R_0^2}+r^2d\theta^2+r^2\sin^2\theta d\varphi^2\right\} \quad (1)$$

Here $r$, $\theta$, $\varphi$ are space-co-ordinates, $t$ is a time-co-ordinate*, and $k$, $R_0$ are constants which, together with the undetermined function $g(t)$, we leave for later discussion, only remarking here that (1) defines not one, but a whole class, of space-time models.

To arrive at this formula we need no theory of gravitation or of dynamics: we require only the following assumptions[3]. First, the aggregate of spiral nebulæ must form a *homogeneous* aggregate, which means that the nebulæ must be uniformly distributed in space at each 'instant' $t$; secondly, each nebula must trace out a geodesic of space-time; and thirdly, these geodesics must form a 'coherent' set. The last assumption means that the aggregate of moving nebulæ is imagined as having had a continuous past history and not as having been formed by the fusion of two or more independent streams of nebulæ. In short, the metric (1) is derived from kinematic considerations together with the hypothesis of uniformity of distribution in space of the nebulæ.

Apart, however, from differences in their theories of dynamics and gravitation, general and kinematical relativity differ at this preliminary stage also. One important difference is that general relativity presupposes only that a model of the universe must possess *some metric or other*, the particular class of metrics (1) holding if it is in fact the case that the aggregate of nebulæ satisfies the homogeneity conditions set out above. If it should turn out that

* Purely as a matter of mathematical convenience, $t$ and $r$ are both measured in the astronomical unit of distance, the *parsec*, which is $3{\cdot}08 \times 10^{18}$ cm. The time in years is $t/c$, where $c$ is the velocity of light expressed in parsecs per year.

these conditions are not satisfied at present or were not true at some time in the past, general relativity would deal with the situation by discarding the models (1) and replacing them by others corresponding to the non-homogeneous conditions found to exist. Kinematical relativity, on the other hand, *postulates* homogeneity as the intrinsic character of the aggregate, and so is necessarily led to one or other of the models (1) as the only possibility. Another important difference is that, whereas in general relativity the paths of *all* material particles are by hypothesis geodesics of space-time, in kinematical relativity only the paths of the 'particles' representing the spiral nebulæ have this character. The paths of 'free' particles are curves of a more complicated type.

The uniformity postulate implies that the 'points' representing the spiral nebulæ are mathematically interchangeable with one another. It is therefore admissible to select one of them as representative, and it is usual to choose the one at the origin, $r = 0$, $\theta = 0$, $\varphi = \theta$, and to regard the nebula it represents as the typical nebula from which all the rest are being surveyed.

## Multiplicity of Models

We have already mentioned that the general considerations from which the metric (1) is derived do not define it completely, so that a wide multiplicity of models is possible. This arises, first because the function $g(t)$ is not explicitly obtained, the only restriction imposed on it being that $g(t_0) = 0$, where $t = t_0$ is the 'present moment'. Secondly, the constant $k$ can have one or other of the three values $+1$, $0$, $-1$, according as space is spherical, flat or hyperbolic, while $R_0$, the so-called 'radius of space at the time $t = t_0$', determines the scale of the model (for $k = +1$ or $-1$) and may have any positive value.

The mathematical distinction between one model and another is unfortunately not a simple one, but it is very important. The geometrical properties of the different models correspond to intrinsic differences in the velocities and accelerations of the points representing the nebulæ, in their number and their distribution in space under the general over-riding requirement that the distribution is to be homogeneous. We begin by defining the 'coefficients of the metric', namely, the factors

$$1, \quad -e^{g(t)}/(1 - kr^2/R_0^2), \quad -e^{g(t)}r^2, \quad -e^{g(t)}\,r^2 sin^2\theta,$$

which multiply the squares of the 'differentials of the co-ordinates' $dt$, $dr$, $d\theta$, $d\varphi$. A model is defined completely when the function $g(t)$ has been explicitly stated and the values of $k$ and $R_0$ assigned. For example, the choice

$$g(t) \equiv a(t - t_0), \quad k/R_0^2 = 0,$$

where $a$ is a constant, defines a 'de Sitter' universe. Now the intrinsic geometrical properties of a model depend on the coefficients of its metric, and we might therefore jump to the conclusion that models with different coefficients were necessarily intrinsically different. This, however, is not the case, because of the possibility of performing co-ordinate transformations within a given model the sole effect of which may be to alter the mathematical expression of the metric without affecting the intrinsic geometrical properties of the model. An example may make this point clearer. The ordinary 2-dimensional Euclidean plane, when expressed in terms of rectangular co-ordinates, has the metric

$$ds^2 = dx^2 + dy^2\,;$$

but it becomes

$$ds^2 = dr^2 + r^2d\theta^2,$$

when polar co-ordinates are used. In the first case, the coefficients of the metric are 1,1, in the second, 1, $r^2$. But, whichever form we use, the Euclidean geometry of the plane is the same: the three angles of a triangle sum to 180°, straight lines are of infinite length, and so on. The general mathematical problem of determining whether, of two given metrics, one can be turned into the other by a co-ordinate transformation, has not been solved in a manner which can be conveniently applied in practice. But it has been discovered that the coefficients of the metric determine a property called the 'curvature' of the model, and that the equivalence of two models depends on establishing the identity of their curvatures in a certain technical sense. A particular case of importance is that in which the curvature is identically zero, since this can be detected irrespective of the co-ordinate system used. The model of zero curvature is that of *special relativity*, the metric of which is expressible in a variety of useful forms by changing the co-ordinate system. In the customary form, we use a co-ordinate system $t_1$, $r_1$, $\theta$, $\varphi$, with the coefficients $g(t_1) \equiv 0$, $k/R_0^2$ infinite, so that

$$ds^2 = dt_1^2 - (dr_1^2 + r_1^2d\theta^2 + r_1^2sin^2\theta d\varphi^2). \qquad (2)$$

Another form which we shall need later is obtained by the co-ordinate transformation

$$t_1 = t(1 + r^2/t_0^2)^{1/2}, \quad r_1 = rt/t_0, \quad \theta = \theta, \quad \varphi = \varphi\,; \quad (3)$$

so that the metric (2) now becomes

$$ds^2 = dt^2 - \frac{t^2}{t_0^2}\left(\frac{dr^2}{1+r^2/t_0^2} + r^2d\theta^2 + r^2sin^2\theta d\varphi^2\right). \quad (4)$$

The last formula is seen to be a special case of (1) in which

$$g(t) = 2log(t/t_0), \quad k = -1, \quad R_0 = t_0, \qquad (5)$$

and serves to illustrate the point that a different choice of $g$, $k$ and $R_0$ may yet lead to the same model in two different guises. In (3) and (4) we may regard $t_0$ as the present moment in the history of the typical nebula at the origin of space co-ordinates and the co-ordinate transformation then shows that for points near this origin and for times near to $t_0$, the co-ordinates $t_1$, $t$ and $r_1$, $r$ are approximately equal.

It is essential to remember that two genuinely different models—models the curvatures of which are intrinsically different—cannot be reduced to one another by co-ordinate transformations, a point sometimes slurred over in cosmological discussions. To illustrate again from 2-dimensional geometry: the Euclidean plane with metric $ds^2 = dx^2 + dy^2$ cannot be turned into the surface of a sphere with metric $ds^2 = d\theta^2 + sin^2\,d\varphi^2$ the curvature of which is unity. This is the reflexion in differential geometry of the fact that the geometrical properties of the surface of the sphere are not the same as those of the plane, one instance of the difference being that the angles of a spherical triangle no longer sum to 180°.

## Different Time-scales

While we are still discussing co-ordinate transformations, we may mention a transformation of the time co-ordinate which plays a great part in kine-

matical relativity. It has the effect of turning the metric (1) into the form

$$ds^2 = q(\tau)\left\{d\tau^2 - \left(\frac{dr^2}{1-kr^2/R_0^2} + r^2d\theta^2 + r^2 sin^2\theta d\varphi^2\right)\right\} \quad (6)$$

The transformation is obtained by evaluating the integral in

$$\tau = A + \int e^{-\frac{1}{2}g(t)}dt, \quad (7)$$

where $A$ is an arbitrary constant, and then expressing $e^{g(t)}$ as a function of $\tau$ which we have denoted symbolically by $q$. It follows from (7) that for every choice of the function $g$ which causes the integral to 'diverge at $t = 0$', as the mathematicians would put it, the zero value of $t$ will correspond to an infinite value of $\tau$. In other words, in any such model, if the history of the universe be supposed to begin at the zero value of $t$, it will begin at an infinitely remote past time when the $\tau$ time-scale is used.

## The Red-shift

There is another result common to general and kinematical relativity which depends only on the form of the metric (1) and on the assumption that the path of a light-ray in space-time is a null-geodesic. This is that all nebulæ when viewed from the typical nebula will exhibit a displacement of the lines in their spectra either towards the red or towards the violet, according to the form of the function $g(t)$, and that there is an equilibrium model possible (the 'Einstein' universe) in which no displacement occurs. It is a matter of observation that the existing aggregate of nebulæ viewed *at the present moment* exhibits displacements to the red only. The amount of the displacement is, to a first approximation, $\frac{1}{2}g'(t_0)$ per unit of distance, the moment of observation being $t_0$ and the dash denoting the derivative of $g$ with respect to $t$. Hubble's observations[4] of the red-shift yield the numerical value[5]

$$\tfrac{1}{2}g'(t_0) = 1{\cdot}83 \times 10^{-9}\,\text{parsec}^{-1}. \quad (8)$$

We thus obtain the important result that the present-day observations of red-shift do not permit us to distinguish between one model and another: they merely provide us with an instantaneous value of the derivative of $g$ with respect to $t$.

## General Relativity and Eddington's Model

How then are we to discover the model to which the universe we see around us does, in fact, correspond? Sir Arthur Eddington's answer[2] to this question is that the combination of Einstein's gravitational equations with those of a generalized quantum theory will identify the model, and that the numerical values of any constants needed to specify it are deducible from the constants of atomic physics measured in the terrestrial laboratory.

We cannot attempt here an account of the quantum theoretical part of Eddington's theory, but we must briefly state Einstein's gravitational equations. These connect the properties of matter such as density, pressure, momentum, etc., with the curvature of the model. In the models with metric (1), it is found that the matter can have two properties only, namely, density, $\rho$, and pressure, $p$. The former is interpreted as the density of all matter contained in the nebulæ imagined as smoothed out into a uniform cloud; and the latter, as the effect of small random motions of the nebulæ and of radiation pressure. It is to be expected, therefore, that this pressure will not be sensibly different from zero, and this value is commonly assumed in cosmological investigations. The pressure and density are connected with the curvature of the model and with the celebrated cosmical constant $\lambda$ by the equations

$$\varkappa p = \lambda - 3\left(\frac{g'}{2}\right)^2 - g'' - \frac{k}{R_0^2}e^{-g} \quad (9)$$

$$\varkappa\rho = -\lambda + 3\left(\frac{g'}{2}\right)^2 + \frac{3k}{R_0^2}e^{-g}, \quad (10)$$

$\varkappa$ being proportional to the constant of gravitation $G$.

An important feature of Eddington's theory is the assumption that the expansion of the universe (manifested by the red-shift) began from a state in which the nebulæ were in equilibrium in a space of finite extent. Such a condition is found in the 'Einstein' universe the equilibrium of which, moreover, is unstable. There are models which are initially in the Einstein state but do not remain in it and start expanding instead. Eddington's model is one of these, and he can specify it completely with the help of his generalized quantum theory. His results are as follows: the model is spatially finite ($k = +1$); the total mass, $M$, of the matter it contains is also finite and fixed in amount, and the cosmical constant, $\lambda$, has the value $(\frac{1}{2}\pi c^2/\varkappa M)^2$. The radius of space, $R_0$, lies between 10 and $25 \times 10^8$ parsecs, and it is in calculating this quantity that Eddington makes one of his rare appeals to astronomical observation for an estimate of the density of matter $\rho$ in the model. The initial value of the radius is about one fifth of $R_0$. The function $g(t)$ is the simplest solution of equation (9) with $p = 0$ and is expressible in terms of logarithmic functions. But perhaps the most remarkable result of Eddington's theory is his calculation of the maximum possible value of $\frac{1}{2}g'(t)$ without appealing to astronomical observation but from the constants of atomic physics. Converting his 'speed of recession' to the units we are using, we find that $\frac{1}{2}g'(t) = 1{\cdot}91 \times 10^{-9}$ parsec$^{-1}$, which is in very remarkable agreement with the observed value (equation (8) above). Lastly, the time, on the $t$-scale, since the expansion of the model began is about $90 \times 10^9$ years. Thus, using theory together with the values of the constants of atomic physics, Eddington constructs his model, having made little or no appeal to astronomical observation in the process.

## Kinematical Relativity: Milne's Model

In contrast to general relativity, Milne does not start from the metric of the model, nor does he accept Einstein's equations (9) and (10) as defining the properties of matter in the model. But the definitions which he does use and, in particular, the requirement that all his equations shall be invariant under Lorentz transformations of the co-ordinates lead him[6] to the model (2) of special relativity and, through a co-ordinate transformation, to the form (4) of its metric. All the arguments and definitions are *a priori* and theoretical, Milne's object being to construct a model of the universe with no empirical elements.

The model of special relativity in terms of the co-ordinates $t$, $r$ (Equ. 3) has interesting properties. In the first place, 'space' is now defined as the 3-dimensional 'surfaces' $t =$ constant, and, since $k$ is equal to $-1$, it is hyperbolic and of infinite extent.

In the second place, the form of $g(t)$ is such that the zero value of $t$ corresponds to zero value for the radius of space. Physically, we should have to imagine all the nebulæ concentrated at a point with infinite density, and this is indeed the moment of Milne's 'creation'. The present radius of space, $R_0$, is identical with the age of the universe on the $t$-scale and is deducible directly from the red-shift formula (8). The radius is therefore $5 \cdot 5 \times 10^8$ parsecs, and the time since the critical moment $t = 0$ is $1 \cdot 8 \times 10^9$ years. Thus the time-scale is far shorter than in Eddington's model. The two models are, of course, not reducible to one another by a co-ordinate transformation, their curvatures being intrinsically different.

Milne's dynamical and gravitational theory is again without empirical elements, and depends on a definition of the acceleration of a free particle which makes the acceleration formula invariant under Lorentz transformations. He proves that the resulting equation of motion of the free particle can be reduced approximately to that of a particle moving under Newton's inverse square law of gravitation provided that two very remarkable conditions are fulfilled. The first condition is that the constant of gravitation, $G$, is not a constant at all but varies with the time, and the second is that the 'time' of dynamics and gravitational theory is $\tau$, whereas the 'time' of cosmological investigations is $t$ or $t_1$. This ambiguity in time-scales has hitherto escaped notice because $\tau$, $t$ and $t_1$ are all indistinguishable locally. The relation between $\tau$ and $t$ in this model is, by equations (5) and (7),

$$\tau = t_0 \log (t/t_0) + t_0,$$

the constant $A$ being adjusted so that $t = t_0$ shall correspond to $\tau = t_0$. The model, moreover, is of the kind in which the integral (7) 'diverges at $t = 0$', so that the 'time' from 'creation' is finite or infinite, according as we measure it by means of $t$ or of $\tau$, respectively. We have seen that this property is not peculiar to Milne's model but occurs in a much wider class, and is possible in general, just as much as in kinematical, relativity. It is the 'dynamical' significance attached to $\tau$ that gives this time-variable whatever importance it may possess, *not* the infinite life-time for the universe to which it leads.

Milne's model is thus an entirely theoretical structure containing one disposable constant only, $t_0$, the value of which is fixed by the red-shift observations.

## Model Deduced from Observation

We have so far discussed models arrived at in the main on *a priori* grounds. But it is also possible to treat cosmology as a branch of mathematical astronomy, and to take the appeal to observation as the important test. There is indeed a very close analogy in this respect between Newtonian planetary theory and cosmology. The former predicts on theoretical grounds that the path of a planet or comet may be an ellipse, a parabola or a hyperbola; the latter, that the observed universe may conform to one or other of a wide class of models. It is not regarded as satisfactory to announce *a priori* that the orbit of a newly discovered comet must be an ellipse, for example, and to disregard the observations of its path however few and inaccurate they may be. Yet such an attitude is not uncommon among cosmologists.

Pursuing this possibly old-fashioned and certainly unpopular line of thought, I have tried to identify the model to which the universe conforms by using astronomical observations combined with Einstein's gravitational equations ((9) and (10) above). We have the following observations at our disposal: measurements of the red-shift, estimates of the number of nebulæ per unit volume and of the mass of an average nebula; and, most important of all, observations[4] of the distribution of nebulæ 'in depth'. These give the average number of nebulæ per unit area of sky at successively fainter apparent magnitudes. None of these observations are either so accurate or so complete as they might be, but the important point is that they *do* give a solution of the cosmological problem. In reaching it, I discarded Hubble's method of applying *a priori* 'corrections' to the observations, since I was able to show that one at least of these corrections was equivalent to imposing an unacceptable restriction on the function $g$. Hubble[4], indeed, had arrived at a model in which space was finite ($k = +1$) but of such small extent that he rejected the interpretation of the observations by means of *any* of the models (1) in favour of an account in terms of the loss of energy of light-radiation as it traversed space. Nevertheless, taking Hubble's observational figures without applying 'corrections', I was able to show[5] that they led to a model with the specifications: $k = -1$, $R_0 = 4 \cdot 515 \times 10^8$ parsecs, $\lambda = -0 \cdot 050 \times 10^{-16}$ parsec$^{-2}$. The function $g(t)$ is a solution of the equation (9) with $p = 0$ expressible as an elliptic function. The model, therefore, has hyperbolic space, which is of infinite extent, and the expansion begins at $t = 0$ from an infinitely concentrated state as in Milne's model. The function $g$ is of the kind for which the integral in (7) does not diverge at $t = 0$, so that the life-history of the model is finite, whichever time-scale we use. On the $t$-scale it amounts to $1 \cdot 5 \times 10^9$ years. The curvature of the model is intrinsically different from that of Eddington's or Milne's, so that it cannot be transformed into either of them by co-ordinate transformations. No doubt more accurate observations will, in the future, alter the model, just as the orbit of a comet is perhaps found to be a parabola on the basis of the first available observations of its path but later turns out to be an ellipse as more numerous and accurate measurements accumulate.

In deriving this model, I made use of Einstein's equations, which do not apply in Milne's theory. But using the equations which take their place in kinematical relativity, I have not succeeded[7] in reconciling the predicted and the empirical formulæ for the distribution of nebulæ in depth to the same degree of accuracy as is possible in general relativity.

## Conclusion

We are thus presented with three different models of the universe, two of which are based essentially on theory whereas the third is derived by the maximum of appeal to observation. Eddington's model implies a time-scale some fifty to sixty times longer than the time-scales of the other two. Milne, however, gives a physical interpretation to a second time co-ordinate in terms of which the universe has an infinite life-time. All three models imply that the universe began expanding from somewhat peculiar initial conditions: Eddington's from a state of unstable equilibrium; the other two, from 'explosions' at a point. The calculated time-scales are measured from these initial states and are therefore dependent

on the assumption that the roughly homogeneous conditions observed at the present day have persisted through the past history of the universe. It is scarcely necessary to emphasize the speculative and provisional nature of such extensive extrapolation.

[1] Haldane, J. B. S., *Nature*, 153, 155 (May 6, 1944).
[2] Eddington, A. S., "The Combination of Relativity Theory and Quantum Theory", *Dublin Inst. Adv. Studies*, A, No. 2 (1943). A summary of the astronomical implications of the theory appeared in the *Observatory*, 65, 209 (August 1944).
[3] Robertson, H. P., *Rev. Mod. Phys.*, 5, 22 (1933).
[4] Hubble, E., *Astrophys. J.*, 84, 517 (1936).
[5] McVittie, G. C., *Proc. Phys. Soc.*, 51, 529 (1939).
[6] Milne, E. A., *Proc. Roy. Soc.*, A, 158, 324 (1939); 159, 171 (1939).
[7] McVittie, G. C., *Z. Astrophys.*, 14, 312 (1937); 16, 21 (1938).

# OBITUARIES

## Prof. G. F. Stout

BY the death in Sydney of Prof. G. F. Stout, emeritus professor of logic and metaphysics in the University of St. Andrews, at the age of eighty-four, British philosophy and psychology have lost one of its most representative and distinguished figures. A first class in the Classical Tripos in Cambridge in 1882, followed in the next year by a first in the Moral Sciences Tripos, seem, on the face of it, strange preparation for a man who was to become a dominant figure in British psychology for the next two generations, and who, as late as 1936, after fifty years of academic life, could enter into equal fray with the new *Gestalt* experimental psychologists from Germany. But three further factors must be taken into account: the presence of Ward at Cambridge, the nature of British philosophy and Stout's own penetrating insight. That Ward was one of the dominating influences in his life, Stout himself was ever ready to admit. Ward's article on psychology, in the "Encyclopædia Britannica" of 1885, ultimately embodied in his "Psychological Principles", was the precursor of Stout's "Analytic Psychology" (1896) and his "Manual of Psychology" (1898), and both these latter books bear the marks of this influence. But both Ward and Stout were following in the clearly marked tradition of British psychologists and philosophers from the seventeenth century onwards, and Stout himself was, until his death, the ablest survivor of a type of philosophy which included Locke, Hume, the two Mills and the Scottish school.

Neither Ward nor British tradition, however, can account for the fact that a text-book on psychology written nearly fifty years ago is still, despite the many changes in technique and outlook, an indispensable work for teachers and students alike. Here two points call for comment. The first was Stout's superb intellect, with its keen insight into philosophical and psychological problems, and the second, his freshness of mind, which never lost its interest in his subject and enabled him to revise one edition after another.

Stout left Cambridge in 1897 and was for two years lecturer in Aberdeen in comparative psychology and for four years Wilde reader in mental philosophy at Oxford. In 1903 he was appointed to the chair at St. Andrews. From this period his writings were, in the main, on epistemology and metaphysics. In the former, the influence of Plato, and particularly the Theatetus and Sophist, is obvious; in the latter, his animism and his views on the body and mind are Spinozistic. But Stout was never merely a copy of any other thinker; his originality was too strong for that: and for this same reason, although his knowledge of philosophical literature was astounding, he was not a mere scholar. He was a thinker first and always, and in his reading he both re-thought and re-moulded. It is not possible in a short notice to go into details of Stout's philosophy, but I hazard the opinion that if readers of *Nature* would ponder the Gifford Lectures (Stout, "Mind and Matter", 1931) of a former editor of *Mind* (Stout edited *Mind* from 1891 until 1920) British scientific philosophy would be a far better thing than it is at present.

To the bulk of St. Andrews students—Stout, in the main, lectured only to a small number of advanced students—and to most members of the staff he was a mythical figure, spoken of with awe and around whom legends and anecdotes were spun of a recluse living in a rarified atmosphere of pure thought. Those of us who worked with him and who talked and walked with him for many years knew what a caricature this was. In addition to his extensive knowledge of philosophical and psychological literature, Stout was one of the best read men of a reading generation, in literature, history and in many branches of science, and his judgment of men and affairs was unerring. He seemed to have read (and to remember) everything, and he showed the same penetrating insight in his judgment on affairs that characterized his professional work. Those who only know the latter never really knew Stout, who will always be remembered by his friends as a man who not only gained the highest distinction in his own branch of study but who had also assimilated the matter and spirit of European culture from the Greeks downwards. Even among academics he was an aristocrat. We of a later generation knew that, as did men like Ward and Bradley of his own. J. N. WRIGHT.

## Dr. E. N. Miles Thomas

WITH the death of Dr. E. N. Miles Thomas on August 8, there passed one of the most brilliant women botanists of the century. Educated at the Mays High School (Home and Colonial School Society), she studied also at University College, London (where she was later made a fellow) and at the Imperial College of Science and Technology. Her contact with Miss Ethel Sargent, to whom she acted as research assistant (1897–1901), and with Mr. (later Prof.) A. G. Tansley was probably responsible for her life-long devotion to problems of seedling anatomy.

Her appointment as lecturer at Bedford College in 1908 marked the inauguration there of a separate Botanical Department, and in 1912, she was also awarded the status of reader in the University of London. The Department made rapid progress under her vigorous leadership and was already well established in the new premises of the College in Regent's Park when war broke out in 1914. Like others, Dr. Thomas felt the urgency of war claims, and when her appointment terminated in 1916 she became an inspector of the Women's Land Army for London and the Home Counties. Afterwards she became acting head of the Botanical Department in University College, Cardiff, during 1918–19 and keeper of the Department of Botany in the National Museum of Wales during 1919–21. In 1923, she was appointed lecturer in biology at University College, Leicester,

a position which she held until her retirement in 1937. Her activities in these various spheres were tireless, but as a life member of the British Association for the Advancement of Science, she also took part in many of the meetings, including those of Australia (1914), Canada (1924), and South Africa (1929); also acting as recorder (1920, 1921) and vice-president (1933) to Section K. She was elected fellow of the Linnean Society in 1908 and served on the Council during 1910–15. She was deeply interested in questions affecting the professional status of women workers. She also tried to promote the formation of a central botanical research institute; but the funds collected were insufficient and were used in furtherance of research by other means. She had friends in many lands, and in 1924 served, appropriately, on the executive committee of the Imperial Botanical Conference.

Dr. Thomas's published work included double fertilization (*Ann. Bot.*, **14**; 1900); anatomy of *Acrostichum* (*New Phyt.*, **4**; 1905) and a series of articles on seedling anatomy, reinforced by those of some of her students. Her name is especially associated with the theory of the double leaf-trace (*New Phyt.*, **6**; 1907); but the trend of her views on more general questions of seedling anatomy is clearly indicated by a series of summaries (British Association Reports for 1906, 1914, 1923 and 1924) as well as by longer articles (*Ann. Bot.*, 1914; *Proc. Linn. Soc.*, 1923). She had hoped to develop these researches further, but failing health and other circumstances prevented her from bringing her work to full fruition. On her breakdown in 1940, her slides, records, etc., were catalogued and placed in the Jodrell Laboratory, Kew. She was married to Mr. H. H. F. Hyndman, but his sudden death in 1934 brought to an untimely end a particularly happy union. The shock, though faced with characteristic courage, was undoubtedly one of the causes precipitating her final breakdown.

# NEWS and VIEWS

## British Non-Ferrous Metals Research Association: Retirement of Dr. Harold Moore, C.B.E.

DR. HAROLD MOORE, who will retire from the position of director of the British Non-Ferrous Metals Research Association on October 31, has occupied that position for the last twelve years. Dr. Moore is a native of Middlesbrough, and received his metallurgical training from the late Dr. J. E. Stead, taking a London degree. After two years in a Northamptonshire blast-furnace works he joined Messrs. Beardmore at their Parkhead works, where he was engaged on problems of armour-plate manufacture. In 1904 he became chief metallurgist in the Research Department, Woolwich, being given the title of Director of Metallurgical Research in 1919. Besides controlling a staff engaged in research on armaments, he did valuable work on the development and interpretation of the hardness test, and in collaboration with S. Beckinsale published an important investigation on the season cracking of brass, work which arose out of difficulties with cartridge cases, but was the starting point of a study which has been actively taken up by others.

Dr. Moore was awarded the C.B.E. in 1932, in which year he was appointed to succeed Dr. R. S. Hutton as director of the British Non-Ferrous Metals Research Association. During his tenure of the directorship the equipment and staff of the laboratories in Euston Street have grown considerably, and many investigations of great value to the non-ferrous metals industry have been carried out. Dr. Moore has from the beginning taken an active part in the work of the Institute of Metals, of which he was president during 1934–36. In 1943 he received the Platinum Medal of the Institute. He has also served on many councils and committees concerned with metallurgy. In all these capacities his personal qualities have contributed largely to the smooth working of research organizations.

## Royal Holloway College: Chair of Mathematics

THE chair of mathematics at the Royal Holloway College, vacant through the resignation of Prof. Bevan Baker, has been filled by the appointment of Prof. W. H. McCrea. Since 1936 Prof. McCrea has been professor of mathematics at the Queen's University, Belfast, but for some time has been on leave in London on war service. Prof. McCrea had previously been an appointed teacher in the University of London, while holding an assistant professorship at the Imperial College during 1932–36, and during that time he took an active part in the scientific life of London, particularly in connexion with the Royal Astronomical Society. In addition to being an excellent teacher to university students over a wide range of mathematical ability and interest, his scope as a researcher is unusually extensive. He is specially distinguished for his researches in astrophysics, to which he has contributed many fertile ideas. His theory of the solar chromosphere, modifying an earlier theory by Prof. E. A. Milne which attributed the main support to selective radiation pressure, is generally accepted, and includes pioneer work that first showed the importance of turbulence for the structure of the sun's atmosphere. He also constructed a model of a stellar atmosphere based solely on physical as distinct from astronomical data, thereby initiating a method of investigation afterwards widely followed. Among his other astrophysical researches are a theory of the ejection of matter from 'new' stars (novæ), and a study of the drag of one gas on another through which it is streaming. Prof. McCrea has also shown marked originality in other fields, which include the quantum theory of specific heats and of quadrupole radiation, cosmological relativity theory, wave-tensor calculus, and differential and difference equations.

## New Chair of Geography at McGill University

MR. GEORGE H. T. KIMBLE has been appointed first professor of geography and head of the newly created Department of Geography in McGill University. Until the outbreak of the War, when he volunteered for the Naval Meteorological Service, Mr. Kimble was lecturer in geography in the University of Reading. He took his bachelor's and master's degrees at King's College, London, during 1927–31, where he studied under Prof. Ll. Rodwell Jones and the late Prof. A. P. Newton, and did his early work in historical geography. The results, so far published,

of these researches are contained in "Geography in the Middle Ages" (Methuen, 1938), in a memoir accompanying the Royal Geographical Society's reproduction of "The Catalan World Map of the R. Biblioteca Estense at Modena" (1934), and in a critical edition of Pacheco's "Esmeraldo de Situ Orbis", published by the Hakluyt Society (1937). On the human side he has made a number of studies of marginal environments and economies, notably of the Berbers of the Algerian Atlas (*Geog. J.*, 1941), and shortly before the War he wrote a popular introduction to the subject called "The World's Open Spaces" for Nelson's Discussion Series. The preoccupations of the past five years may be held to explain the temporary diversion of his interests as revealed in his most recent publications, namely, "The Shepherd of Banbury's Rules for Telling the Weather" (University of Reading, 1941) and "The Weather" (with Raymond Bush) published by Penguin Books in 1943. Mr. Kimble hopes to take up his new appointment in January 1945.

### Pulkovo Observatory Library

ALTHOUGH information had been received that the most valuable of the instruments had been removed from the Pulkovo Observatory before it was shelled and bombed by the Germans, there had been no news about its valuable library, which contained many rare treasures, including the manuscripts of Kepler. It is now learned from the *Moscow News* that the library had remained in the building, stored away in the basements. After the Observatory had been shelled for three weeks, it was decided to save the library at any cost. In the middle of October 1941, under incessant German artillery fire, the removal of the library was undertaken by the employees of the Leningrad Museums and Park Administration. Truck after truck pulled up to Pulkovo until all the books had been removed. The Observatory is now a mass of ruins, but the Academy of Sciences of the U.S.S.R. has been instructed by the Government to draw up and present by November 1 a project for the rehabilitation of the Observatory.

### Illuminating Engineering Society

THE presidential address delivered by Mr. E. Stroud at the opening meeting of the Illuminating Engineering Society on October 10 took the form of a survey of the Society's activities and its future. The Society was formed by Mr. Leon Gaster in 1909 and its first president was Prof. Silvanus P. Thompson. At that time there was little information in regard to lighting practice, and the instruments available for the measurement of illumination were few and cumbersome. Much original work was done by Mr. A. P. Trotter and other early pioneers to deal with the lighting of schools and libraries and other subjects. The setting up of the Home Office Committee on Factory Lighting in 1913 was an important landmark. During the War of 1914–18 members of the Society did useful work on the measurement of the candle-power of flares and the brightness of radium compounds for coating gunsights, etc., and the year 1915 saw the issue of the first of the series of reports on factory lighting issued by the Departmental Committee. During the first twenty years the foundations of the Society were laid. The floodlighting of London buildings, which accompanied the holding of the International Illumination Congress in London in 1931, did much to direct attention to its work. Efforts were made to create interest in the provinces, where the first centre, in Manchester, was formed in 1932.

From 1934 onwards there ensued a period of development. The membership, at this time about 450, advanced to 850 at the commencement of the present War, and has now reached more than 1,600 —nearly a fourfold increase during these ten years. Several ambitions of the Society have since been realized, such as the formation of the nucleus of a library, the issue of *Transactions* and the establishment of a class of fellowship. This present growth of membership has been mainly due to the development of centres, now ten in number, with which, and with five supplementary groups, there are associated more than a thousand members. The growing recognition of the importance of good lighting is illustrated by the official recognition given to the I.E.S. Code of values of illumination. The inclusion of lighting in the Factory Act of 1937 makes good an omission stressed by Prof. Silvanus Thompson in his inaugural address thirty-five years ago. During the present War the Society has devoted much attention to A.R.P. lighting problems. A series of "Lighting Reconstruction" pamphlets has also been issued. There are various plans in preparation, such as those relating to the education of lighting engineers. In years to come there should be great opportunities for lighting. Closer links should be established with the sister societies in the United States and the Dominions, and international contact should be revived.

### Dried Plasma Sheets for Burns and War Wounds

"IT has often been said," remarks Lieut.-Colonel B. Pollock, U.S.N.R. (*U.S. Naval Bull.*, 42, 1171; 1944), "that this is a burn war." The incidence of burns has greatly increased, and there is urgent need of an ideal coagulum for them. Such a coagulum should be durable, non-contractile, indefinitely pliable, non-toxic, non-irritant, resistant to trauma, bactericidal, painless, not unsightly, and it should contain fibrin and not be costly to make. Dried plasma sheets apparently come closer, he thinks, to these requirements than any other coagulum yet introduced. Dried plasma dissolved in water and dried in a hot oven gives a transparent, slightly elastic, adherent coagulum, and the addition of sulphanilamide or sulphathiazole increases its bactericidal effect. These substances are slowly liberated as the fibrin is used up, and they thus keep the wound clean.

The sheets are made in a Petri dish to a size of 4 in. in diameter. 20 c.c. of sterile water is put in the Petri dish and 1·5–2 gm. of dried plasma added. After this has dissolved 0·2 gm. of sulphanilamide powder is added. This is then dried in an oven at 140° C. until a sheet is formed. This requires 15–20 minutes. After cooling, the sheet should be applied directly to the burn. Sheets can be quickly made by heating the preparation over a Bunsen burner until the sheet separates itself in less than five minutes. The addition of more or less water or plasma thickens or thins the sheet. Its transparency increases or decreases according to the amount of sulphanilamide added. If the preparation is dried for only ten minutes, it forms a paste which is also useful. The sheets tend to curl at the edges as skin does, but this can be overcome by moistening them with water before application. They adhere to a

burn in a few moments and the patient may feel a burning or stinging sensation for one or two or possibly thirty minutes. No dressing is needed. The sheets will adhere to the unbroken skin. They can be kept for weeks if they are moist in a refrigerator; or they may be heated until they are crisp and dry, when they may be stored in a refrigerator. The sheets gave good results when they were applied to indolent, ulcerating war wounds, all of which were infected. Wounds still unhealed after sixty days of other treatment healed in six to nine days. Tissue reactions subsided forty-eight hours after their application. None of the patients was confined to bed and some had shower baths without protection of the plasma sheet. Dry dressings were used at night only.

## Taxation and the Social Structure

THE papers presented before the American Philosophical Society in the symposium on "Taxation and the Social Structure" at its midwinter meeting on February 18–19, 1944, have now been published (*Proc. Amer. Phil. Soc.*, 88, No. 1, 1; 1944). American conditions, with the complex relations between State and Federal taxation, to which there is no exact parallel in Great Britain, make the papers somewhat difficult for British readers to follow. Nevertheless, they are of interest at present in view of the reconsideration of the relations between national and local taxation which is being enforced upon Great Britain by some of the trends towards social security, and also of the bearing of fiscal policy on industrial development, such as the concessions announced by the Chancellor of the Exchequer in relation to obsolescence and research in his last budget speech. In Britain, as in the United States, it is realized that taxation is no passive instrument, but that it inevitably affects the social structure and determines the course of social evolution. Accordingly, taxation policy is an integral part of general social and economic policy, and as such must be recognized in our social philosophy.

Four at least of the papers in this symposium make some contribution to this end, and have a much wider bearing than the issues of Federal and State taxation to which the principles they develop are applied. R. Warren's paper on "The Capitalist and the Social Structure", R. Blough's "Conflict and Harmony in Taxation", H. S. Bloch's "Fiscal Policy and Social Reform as it may affect the Potentialities of the Personal Income Tax", and M. H. Hunter's "The Harmonisation of Fiscal and Social Aims" should make important contributions to clear thinking on these problems. Blough's paper in particular is a challenge to fundamental thought and a plea for further research on the relation of taxation to production and employment.

## Potato Varieties in East Africa

THE problem of potato varieties suitable for East Africa is discussed by R. E. Moreau, of the Amani Research Institute, in the *East African Agricultural Journal*, 9 (1944). The inquiry was concerned with the direct physiological effects of climate on the plant and should give some guide to policy when the desired development of the crop is undertaken. The generally accepted view that *Solanum tuberosum* is an unsuitable crop for hot climates is called in question and the conclusion reached that, given good husbandry, excellent crops of it can be raised in parts of tropical Africa, even though air and soil temperatures seem unfavourably high. The short days appear to be of no practical importance, and it is suggested that there may be some countervailing influence in the tropics, such as increased light intensity which accounts for this. The possibility that potatoes of the *Solanum andigenum* group would do better than United Kingdom varieties of *S. tuberosum* is dismissed on purely climatic grounds, though an exception is made of *S. phureja*, which has the further advantage of possessing a particularly high protein content. It is, however, suggested that United States varieties of *S. tuberosum* merit special trial on the score of their possible better adaptation to heat.

## Public Health in Haiti

IN a recent paper (*Bol. Of. San. Panamericana*, 23, 299; 1944) Dr. Jules Thebaud, director-general of public health in Haiti, states that the public health department in his country employs 542 persons, exclusive of day labourers. Owing to lack of funds, Haiti has hitherto been unable to keep pace in public health works; but it has endeavoured to maintain close relations with the Pan-American Sanitary Office. The population of Haiti is estimated at 3,000,000; in 1942 there were 44,805 births, 12,416 deaths and 3,298 marriages. The principal causes of death in 1942 were contagious and parasitic diseases (25·9 per cent), digestive diseases (14·6 per cent), genito-urinary diseases (6·8 per cent) and respiratory diseases, except tuberculosis (6·1 per cent).

## Announcements

THE Lord President of the Council has appointed Mr. W. J. Drummond, Dr. H. L. Guy, Sir William Halcrow and Mr. W. F. Lutyens to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research, in succession to Sir Joseph Barcroft, Sir Harold Hartley and Sir Frank Smith, who have retired from the Council on completion of their terms of office.

LORD SWINTON, minister resident in West Africa, has been appointed Minister for Civil Aviation, and Sir William Jowitt to be Minister of Social Insurance (designate).

DR. HARLOW SHAPLEY, director of Harvard Observatory, has been awarded the Order of the Aztec Eagle, third class, the highest decoration of the Mexican Government awarded to non-Mexicans, for his promotion of scientific co-operation between the United States and Mexico, and for his assistance in equipping the National Astrophysical Observatory at Tonanzintla, near Puebla, Mexico.

THE forty-ninth annual congress of the South-Eastern Union of Scientific Societies is being held at High Wycombe on October 14. The president-elect, Brigadier F. A. E. Crew, director of biological research at the War Office and professor of social medicine in the University of Edinburgh, will deliver his presidential address on "The Biology of War" at 11 a.m.; sectional presidential addresses will precede this address.

ERRATUM.—Messrs. Baird and Tatlock (London), Ltd., referring to the paragraph entitled "A New Type of Still" in *Nature* of September 23, p. 393, state that in line 15 "motor" should read "heater", and that the results quoted are the average of a number of experiments.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Nutritive Value of Composite Dishes

IN McCance and Widdowson's analytical tables, "Chemical Composition of Foods", values are given for a series of cooked dishes containing several ingredients. These values were calculated from the composition of the listed ingredients and the (experimentally determined) change in weight on cooking.

Clearly, such values can only be utilized in dietary survey work if the recipes of the observed composite dishes approximate very closely to those used by McCance and Widdowson. These authors made a preliminary study of several cookery books so as to ensure that the recipes they used should be 'standard' ones. But the war situation has since changed our ideas even of 'standard recipes', and composite dishes tend to vary from day to day, depending on what is available and what needs using up. Besides which, the composition of one of the most common ingredients (flour) has itself been changed.

It is true that there are limits to the variation which can be introduced without entirely altering the nature of the finished dish, but our experience suggests that, at least for the more watery items, these limits are pretty wide. The accompanying table gives values we have found in practice.

| Values per 100 gm. | Calories | Protein (gm.) | Calcium (mgm.) | Iron (mgm.) |
|---|---|---|---|---|
| Rice pudding 1 | 158 | 4·9 | 138 | 0·17 |
| ,, ,, 2 | 183 | 4·8 | 129 | 0·17 |
| ,, ,, 3 | 88 | 2·7 | 81 | 0·09 |
| ,, ,, 4 | 97 | 2·6 | 73 | 0·09 |
| (McC. and W.) | 185 | 4·5 | 138 | 0·14 |
| Porridge 1 | 66 | 1·7 | 33 | 0·29 |
| ,, 2 | 91 | 2·9 | 53 | 0·54 |
| ,, 3 | 117 | 3·4 | 62 | 0·63 |
| ,, 4 | 135 | 4·0 | 46 | 0·99 |
| (McC. and W.) | 45 | 1·5 | 6 | 0·47 |
| Stew with meat 1 | 103 | 9·2 | 21 | 1·81 |
| ,, ,, ,, 2 | 101 | 8·0 | 23 | 1·57 |
| ,, ,, ,, 3 | 89 | 3·5 | 8 | 0·96 |
| ,, ,, ,, 4 | 97 | 7·3 | 31 | 1·48 |
| ,, ,, ,, 5 | 61 | 6·0 | 15 | 1·23 |
| (McC. and W.) | 108 | 11·1 | 14 | 2·49 |
| Shepherd's pie 1 | 165 | 8·3 | 6 | 1·72 |
| ,, ,, 2 | 149 | 7·8 | 17 | 1·61 |
| ,, ,, 3 | 139 | 8·0 | 13 | 1·67 |
| (McC. and W.) | 125 | 7·1 | 15 | 2·31 |

These values have been obtained by the calculation method as employed by McCance and Widdowson, and the figures from their tables have been included for comparison.

Our method, when dealing with composite dishes in survey analyses, has always been to obtain the recipes and to note the cooking times and methods, and then to apply a concentration factor to give us the relation between uncooked weight and cooked. Recorded weights (as eaten) were then converted back to their equivalent uncooked weights and these broken down into the proportional weights of the various ingredients. As a general rule, the concentration factor applied was that found by McCance and Widdowson, but if observation showed the dish as served to be wetter or drier than is customary, then the concentration factor was varied accordingly.

We prefer this method because we think it makes for greater accuracy. Concentration factors may have differed more than we allowed for, but we feel they will certainly vary within much narrower limits than the list and amounts of the ingredients. There are, however, other advantages also. For example, it enabled us to make direct comparison between one intake and another in terms of basic foodstuffs, since they were known as a total and were not distributed among such items as puddings, stews, cakes, etc. It is easier to make recommendations for improving a dietary when the amounts of different foodstuffs already being used are known. This is particularly true at present when it is necessary to keep within allocated allowances. Moreover, this method enables us to calculate the cost of the dietary without further detailed analysis.

MARGARET W. GRANT.
(University of London Postgraduate Dietetics Course.)

Aug. 31.

## Cancer Research in the U.S.S.R.

IN November last we received a request from Prof. S. A. Sarkisov of the Institute of the Brain in Moscow, who was then in London, to supply some mice bearing transplantable tumours which were to be sent to Moscow for Prof. L. Shabad, formerly director of the Laboratory of Cancer Research in the Institute of Experimental Medicine, Leningrad.

The mice were to be sent by air, and probably they would be exposed to considerable changes of climate, and possibly of atmospheric pressure also. Three batches each of four mice were got ready bearing the following tumours freshly grafted: (*a*) mammary carcinoma 63; (*b*) the Crocker tumour; and (*c*) a sarcoma induced here by Dr. Hieger with the non-saponifiable fraction of human livers. The inclusion of the last tumour was appropriate because these mice embodied a development of the original discovery by Prof. Shabad in 1937, since then confirmed in several other laboratories, that extracts of human livers could produce sarcoma in mice.

Each batch of mice was placed in a wooden box (45 cm. × 30 cm. × 12 cm.) having three apertures of 5 cm. diameter covered with perforated zinc for ventilation, with hay and sawdust as bedding, and a quantity of oats, puppy biscuits and a proprietary rat food sufficient for many weeks. Water was supplied from the bulbs in use here for laboratory animals, and a syringe for filling these and directions to be translated into Russian were provided. The boxes were dispatched on November 23, and Prof. Shabad has reported that all the mice arrived safely in mid-December, and that the three tumours had been grafted successfully in the mice available in his laboratory.

Perhaps this is the longest journey yet accomplished by mice used for the purposes of research; the distance covered was probably of the order of five or six thousand miles. Before the War many such mice crossed the Atlantic on liners, chiefly from west to east, in charge of the butcher, who at sea is the custodian of animals living and dead, but this is a shorter journey without halts and changes, and the conditions of temperature are uniform.

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## Amides, Imides and Peptides

PROTEIN chemistry has its origins in physiology. For the last half-century the group formed by condensing the carboxyl group of an amino-acid with the amino group of another amino-acid has been called a peptide group, and the long molecule formed by condensing a number of amino-acids, a polypeptide. Protein molecules contain numerous peptide links (—CO.NH—) in the backbone of the molecule; they also in most cases carry amido groups (—$CO.NH_2$) as terminal groups of certain of their side-chains.

'Nylon' chemistry has its origins in organic chemistry. Unfortunately, some 'Nylon' chemists have chosen to call the link formed by condensing adipic acids with hexamethylene diamine an 'amide group', and to describe 'Nylon' as a 'polyamide'. 'Nylon' chemistry is now beginning to have an influence on protein chemistry, and the use of the term 'amide' as a synonym for 'peptide' in a field of chemistry where it already has a definite and different meaning is causing considerable confusion.

Surely, in any event, to call the group —CO.NH— an 'amide' or even an 'amido' group is wrong. By general agreement substances carrying an —$NH_2$ group are amines, or an >NH group, are imines. Equally, substances carrying a —$CO.NH_2$ group are amides, and surely if carrying a —CO.NH— group should be imides.

To use the term 'imide' as a synonym for 'peptide' and to call 'Nylon' a polyimide would be correct in the language of classical organic chemistry, and would bring clarity into the relations of protein chemists and 'Nylon' chemists. 'Polypeptide' could well be reserved as a term to describe a product obtained by condensing amino-acids, and 'polyimide' for the products obtained by condensing all other carboxylic acids with organic amines.

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## Chemical Terms, with Special Reference to 'Oxidation', 'Acid' and 'Base'

THE words we use in everyday life often mislead us, because the same word (say 'democracy') means different things to different people. It is clearly desirable that scientific words should mean the same thing to all those who use them, and, so far as possible, that they should signify now what they signified in the past.

We say "so far as possible". When the mechanism of a process, such as the corrosion of iron, becomes better understood, the word 'corrosion' acquires a fuller meaning. This is inevitable and desirable. It would be undesirable, however, in our view, if a particular reaction of iron were considered a corrosion by one chemist and not by another.

There is a tendency to extend the scope of a word to include phenomena which were formerly excluded. This has happened in the past; for example, in the case of the word 'oxidation'. The term, originally applied to processes such as the change of ferrous oxide to ferric oxide, was extended to include the change of ferrous chloride to ferric chloride. This extension took place so long ago that it causes confusion now to none except beginners (to whom it is still a stumbling-block), and it would probably be futile to suggest a change. It seems to us, however, that it would have been better, when it was realized that there was a similarity between oxidations proper and other processes in which the proportion of electronegative element or radical is increased, to coin a new term (say, 'adduction') to cover both sets of phenomena, while keeping 'oxidation' for changes involving oxygen. All 'hydrogenations' are 'reductions', but not all 'reductions' are 'hydrogenations'.

It is impossible to extend the scope of a word to include more phenomena without diminishing its sharpness. In the language of the logicians, increase in the extension of a term leads inevitably to decrease in its intension. The term 'oxidation' now conveys a less precise meaning than 'hydrogenation'.

If this were the only example of the phenomenon it would not be worth while writing a letter about it; unfortunately the process is still at work. There was little disagreement among early chemists about the scope of the words 'acid' and 'base'. When hydrogen ions were discovered the words acquired a fuller meaning, but were still applied to cover approximately the same range of substances.

In the last twenty years, however, the recognition that there is a similarity of action between all substances capable of giving up protons or taking up electrons during reaction has led to the extension of the term 'acid' to include all such, and we have now reached the very undesirable position that, while $A$ and $B$ are agreed that hydrochloric acid in aqueous solution is an acid, $A$ applies the word to $NH_4^{\cdot}$ and water also, while $B$ thinks of $NH_4^{\cdot}$ as the electropositive ion of an important series of salts and of water as the most typically neutral substance in existence.

In a recent paper[1] the following sentence occurs, "We conclude that almost any substance may behave as an acid or a base". The extension of 'acid' and 'base' has become so great that the intension has become practically nothing at all.

We think it is probable that a majority of chemists feel uncomfortable at the application of the term 'acid' to water or 'base' to the chloride ion. Perhaps it is not too late to recognize the undesirability of the process and to agree upon the use of some pair of terms (such as 'proton donor' and 'proton acceptor', or 'electrophilic' and 'electrodotic', or others suggested from time to time) to describe all substances (including acids and bases) which can give up or receive protons (or attract or supply electrons), while preserving 'acid' and 'base' for the compounds which have been described by these words for centuries.

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Sept. 12.

[1] Luder and Zuffanti, *Chem. Rev.*, **34**, 346 (1944).

## Thermal Expansion of Diamond

THE measurements of the thermal expansion of diamond made by Dembowska, which according to Grüneisen[1] appeared to support his well-known formula connecting the specific heat and thermal expansion coefficient of simple solids, covered only

a rather small range of temperature. A satisfactory test of the Grüneisen relationship appeared to require data over a wider range of temperature. I have accordingly measured the change in the lattice spacing of diamond with temperature over the range 25°–650° C.

The X-ray method has been employed, but the technique is rather different from that usually adopted, being designed to enable the rather small expansion of diamond to be measured accurately. It is based on the use of a beam of monochromatic X-rays from a copper target diverging from a fine slit and reflected at the surface of the crystal, the photographic film recording the reflexions being at a considerable distance (80 cm.) from the latter. The octahedral cleavage plate employed is held firmly in a slot at the end of a drawn-out tube of fused quartz, being fixed therein with a suitable cement. The quartz tube is long enough to ensure that its lower end is not sensibly heated up, while the diamond itself is raised to the temperature desired by being enclosed in a small electrically heated chamber. Using a Hartmann diaphragm, three sets of X-ray reflexions are recorded in juxtaposition on the same film, the middle one with the heated crystal and the top and bottom ones as controls at room temperature. From the observed displacements of the $K\alpha_1$ and $K\alpha_2$ reflexions, which appear as sharp and widely separated lines on the film, the relative change in crystal spacing can be readily evaluated. As a further control, the expansions are redetermined with the crystal holder and heating chamber turned round through twice the Bragg angle.

The results of the measurements are shown in the second column of the accompanying table below the line, those above it being the determinations by Dembowska quoted by Grüneisen[1]. The values of the atomic heat have been tabulated from the data of Pitzer[2] below 273° K. and from the data of Magnus and Hodler[3] above that temperature.

| Temperature range | Mean value of the coefficient of cubic expansion ($\alpha$) | Mean value of atomic heat ($C_v$) | $\gamma$ |
|---|---|---|---|
| 84·8–194·1° K. | 0·54 × $10^{-6}$ | 0·233 | 1·19 |
| 194·1–273·2 | 1·74 | 0·866 | 1·03 |
| 273·2–296·2 | 2·91 | 1·351 | 1·10 |
| 296·2–328·1 | 3·51 | 1·605 | 1·12 |
| 328·1–351·1 | 4·35 | 1·870 | 1·19 |
| 298–378 °K. | 4·50 × $10^{-6}$ | 1·870 | 1·23 |
| 378–478 | 6·70 | 2·627 | 1·31 |
| 478–573 | 8·58 | 3·307 | 1·32 |
| 573–673 | 9·81 | 3·874 | 1·30 |
| 673–773 | 10·70 | 4·310 | 1·29 |
| 773–873 | 11·55 | 4·643 | 1·27 |
| 873–923 | 12·30 | 4·829 | 1·30 |

The fourth column of the table shows the Grüneisen number $\gamma$, which is the ratio $\alpha V_0/\chi_0 . C_v$, where $V_0$ is the atomic volume and $\chi_0$ the compressibility of diamond. It is clear that $\gamma$ is not a constant, but increases steadily from about 1·1 to 1·32 and then falls again as the temperature is raised. The theoretical significance of the failure of the Grüneisen law which is revealed by these studies will be dealt with in another communication.

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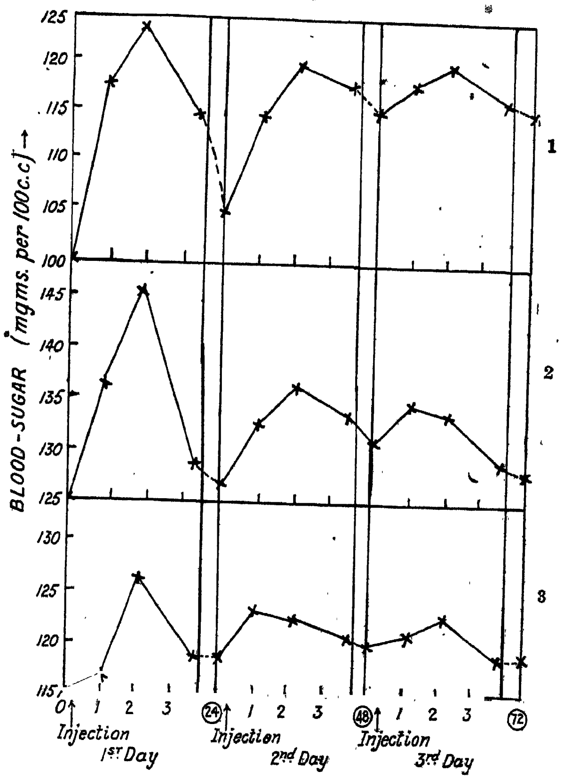
[1] Grüneisen, "Handbuch der Physik", 10, 42 (1926).
[2] Pitzer, *J. Chem. Phys.*, 6, 68 (1938).
[3] Magnus and Hodler, *Ann. Phys.*, 80, 808 (1926).

# Experimental Hyperglycæmia by Injection of Intermediary Fat Metabolism Products in Rabbits

Best and his associates[1] recently reported hydropic degeneration and degranulation of the β-cells through the injection of anterior pituitary extract similar to those observed in the remnants of Allen's partially depancreatized dogs and ascribe those to overwork. The recent findings of Dunn and his associates[2,3] on experimental alloxan diabetes have created great interest in the subject. Though this substance may bring about conditions of glycosuria and hyperglycæmia in animals, the nature of degeneration in the β-cells has been shown to be different from that caused by anterior pituitary injection or through clinical diabetes and the physiological significance has not been known as yet. Adams[4] and Joslin[5] regard obesity as a precursor of diabetes, and it is reasonable to believe that the intermediary metabolism products formed during improper oxidation of fat might be concerned in causing hyperglycæmia and other associated troubles in an individual. It may be recorded here that repeated injection of these types of chemical substances (for example, β-hydroxy-butyric acid, acetoacetic acid, pyruvic acid, etc.) have been found to cause hyperglycæmia in rabbits.

The experiment was made as follows: Adult rabbits weighing about 2 kgm. were selected and injection was given after the animals were allowed to fast for eighteen hours. Blood sugar was estimated initially before injection and after regular intervals for about 4½ hr. according to the method of Hagedorn and Jensen[6]. The animals were fed after this period with usual gram diet and again allowed to fast for




1, Aceto-acetic ester; 2, β-hydroxybutyric acid; 3, pyruvic acid.

Fig. 1.

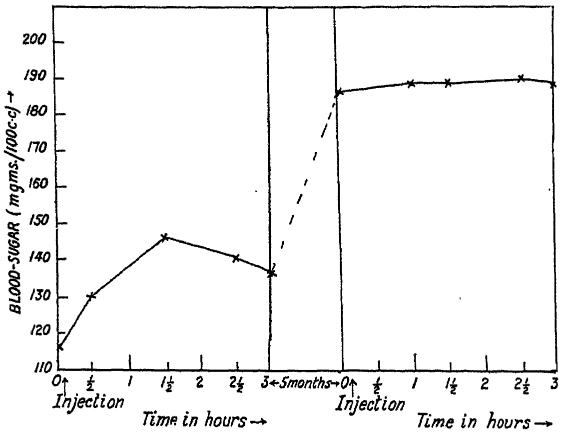



Fig. 2.

eighteen hours. The experiment was repeated for three days in succession on the same rabbits. The nature of change of blood sugar (average from two animals), during the period of experiment, is represented graphically in Fig. 1. It will be seen that in all cases the initial concentration of fasting-sugar on the third day is definitely higher than that on the first day and the nature of the curve is greatly changed. It is also interesting to record that when the set of animals receiving ethyl acetoacetate for three days was allowed to rest for about one month and the experiment repeated, the fasting blood sugar level was found to be lower than that obtained initially (that is, one month before) and a far greater hyperglycæmic effect was observed on injection of the same substance. This lowering of blood sugar level may indicate the mechanism of natural adjustment, possibly by causing hypersecretion of internal insulin. Two rabbits (male) were then injected daily, beginning with 10·0 mgm. of β-hydroxy-butyric acid and gradually increasing to 400·0 mgm. and the blood sugar curves of the animals were obtained on the very first day of injection and after the injections were continued for 150 days. The initial blood sugar value after such period of injection was found to be very high (187·0 mgm. as against 116·0 mgm. recorded on the first day) and the nature of the curve (Fig. 2) was found to be greatly changed. This curve was almost a straight one, indicating severe damage to the insulin-secreting mechanism.

It may be suggested that these intermediary fat degradation products might first stimulate the pancreatic cells, which gradually become fatigued through excessive work, possibly through lesions of these cells in the long run. Further investigations which are in progress may throw more light on the matter.

Our best thanks are due to Prof. J. K. Chowdhury and Prof. B. C. Guha for their kind interest in this work.

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University of Dacca. July 11.

[1] Best, C. H., Campbell, J., Haist, R. E., and Home, A. W., *J. Physiol.*, **101**, 17 (1943).
[2] Dunn, J. S., McLetchie, N. G. B., and Sheehan, H. L., *Lancet*, i, 484 (1943).
[3] Dunn, J. S., McLetchie, N. G. B., *Lancet*, ii, 384 (1943).
[4] Adams, S. F., *J. Nutrition*, **1**, 339 (1929).
[5] Joslin, E. P., *New Eng. J. Med.*, **209**, 519 (1933).
[6] Hagedorn and Jensen, *Biochem. Z.*, **135**, 46 (1923).

## Toxicity to Flies of Derivatives of Eugenol and *Cis*- and *Trans*- *Iso*eugenol

IT appears that any modification in the pentadienyl side-chain of the pyrethrin molecules induces a profound depression in the insecticidal activity[1]. Although the distribution of the double bonds in the side-chain of pyrethrolone is not yet fully established[2], there seems to be little doubt that there is either a terminal $=CHCH_3$ grouping or—less probably—the $=CH_2$ group. Allyl phenols have been found to possess insecticidal properties[3], and it appeared of interest to compare the toxicity in fly sprays of corresponding derivatives of the isomeric phenols eugenol (which contains the allyl grouping) and *iso*-eugenol (containing the propenyl grouping).

The initial tests showed that when sprayed against flies under exactly comparable conditions in kerosine or kerosine-acetone solution alone, or as adjuvants to the pyrethrins, compounds such as ethers of eugenol were usually more effective than solutions of the corresponding *iso*eugenol derivatives; but some of the results led to comparison of the *cis*- and *trans*- forms of the compounds derived from *iso*eugenol. It was then found that solutions of the *cis*- forms of the *iso*eugenol compounds approached the toxicity to houseflies shown by solutions of the corresponding eugenol compounds, whereas the *trans*- forms were noticeably less toxic in solution alone and when included with small quantities of pyrethrins.

This observation appears to be of some interest in view of the fact that comparison of the effect, as pyrethrin synergists of sesamin, of *iso*sesamin and asarinin against houseflies indicated[4] that the nature of the substituents on the benzene ring was the determining factor on the synergistic action of this class of compound, spatial configuration being of little or no importance.

The preparation and physical properties of the pure *cis*- and *trans*- *iso*eugenol derivatives employed will be described elsewhere.

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[1] West, T. F., *Nature*, **152**, 660 (1943).
[2] Gillam, A. E., and West, T. F., *J. Chem. Soc.*, 671 (1942); 49 (1944). West, T. F., *J. Chem. Soc.*, 51 and 239 (1944). LaForge, F. B., and Acree, F., *J. Org. Chem.*, 7, 418 (1942). Cf. LaForge, F. B., and Barthel, W. F., *J. Org. Chem.*, **9**, 242 (1944).
[3] Harvill, E. K., and Arthur, J. M., *Contrib. Boyce Thompson Inst.*, **13**, (2), 79 (1943).
[4] Haller, H. L., LaForge, F. B., and Sullivan, W. N., *J. Econ. Ent.*, **35**, 247 (1942). Cf. Parkin, A. E., and Green, A. A., *Nature*, **154**, 16 (1944).

## Function of Plant Vacuoles

PREVIOUSLY[1], I put forward the view that pinkish vacuoles are receptacles of enzymes for synthesis of various food reserves in plants, lower as well as higher; in support of this I produced evidence of synthesis of food reserves around the pinkish vacuoles of pyrenoids in *Spirogyra* and of synthesis of oil drops around pyrenoids in two diatoms. Additional evidence in favour of the view that pinkish vacuoles are receptacles of enzymes is now brought forward from two sources: (1) synthesis experiments; (2) plasmolysis experiments, in some fungi.

By growing fungi (*Polyporus durus* and *Phomopsis* sp.) in fatty acids and glycerine medium, the first formation of oil drops was noticed around the vacuoles in the course of two days, and by growing them in

4 per cent sucrose or glucose medium the formation of glycogen granules appeared in the same position. In a living cell intracellular enzymes never come out of the vacuoles, but remain enclosed within the vacuolar membrane; starch, glycogen, fats and proteins are synthesized just on the external surface of the vacuolar membrane, and they are also hydrolysed at the surface on account of the superficial secretion of enzymes from the vacuoles; then they are absorbed into the vacuolar cavities. But extra-cellular enzymes in fungi come out by way of exudation from the growing tips of hyphæ. Vacuoles are, thus, the seats of phenomena of synthesis as well as of hydrolysis, all reactions taking place at the surface external to the vacuolar membrane. They are not merely passive accumulators of diverse metabolic products and secreted substances soluble in water, but are the principal sites of chemical affinities in the cell due to the accumulation of enzymes.

From plasmolysis experiments in glucose, sucrose and sodium chloride solutions, it follows that when the perivacuolar membrane is damaged, there is leaking out of enzymes (proteases, diastases and lipases) which act on the protein and glycogen granules and fat drops, and transform them into soluble substances, and the mitochondria become vesiculized; their lipo-protein complex breaks down with liberation of lipides. Thus, a gradual liquefaction of the cytoplasm is brought about. The liberated lipides increase in number, some of them fuse into large globules, leading ultimately to a fatty degeneration of the hyphæ.

Experimental facts lead to the conclusion that the plant vacuoles function as storehouses of enzymes.

Details of these experiments with discussion of current theories and with illustrations are expected to be published soon elsewhere.

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[1] Bose, S. R., *Bot. Gaz.*, **104**, 633 (1943).

## Paracrinkle Virus and Inheritance

IN a recent article[1], I have argued that viruses and what I call plasmagenes[2] are derived from cell proteins. On my view, these undifferentiated proteins may come to acquire the properties either of infection or, alternatively, of inheritance, by processes of adaptation which I attempted to describe. I also represented these processes in a diagram (Fig. 3) in which arrows showed the conceivable and, to me, probable directions of evolutionary change.

Four workers in plant breeding and virus research now raise objections to this view[3]. They take the case of the paracrinkle determinant of the King Edward potato to which I referred and point out, on one hand, that it is a virus since it shows the 'carrier' as well as 'susceptible' reactions with different potato clones, and on the other hand that it is not a plasmagene.

That paracrinkle behaves as a virus was fully demonstrated by the work of Salaman and Le Pelley, to which I directed attention. In their original account they described not two but four reactions of potato varieties with paracrinkle, and a reaction of *Datura*, all fully consonant with its description as a graft-transmitted virus. I consequently referred to it as a virus and I used its behaviour as the strongest evidence, on the plant side, for my argument that viruses can arise from cell proteins and for the arrows that I drew to indicate this origin.

If, on the other hand, paracrinkle had behaved as a plasmagene I should indeed have been surprised. The possibility of so dangerous a particle being transmissible (and therefore having been transmitted) by the seed seems to me, for reasons which I gave, a remote one. I would not exclude it but I would certainly not expect it. For this reason I showed no arrows joining plasmagenes and viruses.

My critics therefore have their facts right so far as they go, but they have overlooked one enormous fact. They say, "There thus seems no fundamental difference in the reaction of King Edward to paracrinkle virus from that of any other 'carrier' variety to the virus 'carried' ". Only one fundamental difference, to be sure, namely, that King Edward *made* it, just as, I am supposing, the fowl and the mouse *made* their viruses.

It occurs to me that what my critics have not understood is the notion (which is perhaps a new one, although it seems fairly obvious) that cell proteins, characteristically produced by a nucleus of a particular new genotype, may have the capacity for indefinite self-propagation even when subject to other nuclei. Such proteins will sometimes have the potentiality of developing, either into plasmagenes or into viruses, according to their distributions in development or their opportunities in infection. They may even, by mutation and otherwise, cause cancer in the examples I have quoted.

A careful study of my article, and if necessary of the book to which it is a footnote, would, perhaps, make my premises and argument clear and leave no ground for the misunderstanding of particular phrases.

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[1] *Nature*, **154**, 164 (1944).
[2] "The Evolution of Genetic Systems" (Cambridge, 1939).
[3] Carson, G. P., Howard, H. W., Markham, Roy, and Smith, Kenneth M., *Nature*, **154**, 334 (1944).

## Plant Nutrients in the Sea

IN a recent issue of *Nature*[1], Prof. J. Ritchie speculates "upon a day . . . when the International Fisheries Commission of the nations bordering the North Sea may discuss, along with its programme of researches, the allocation of sums to be contributed by each nation for chemical nutrients in the assurance that these will support a larger fish population and an increased fishing fleet in the North Sea". Prof. Ritchie surely does not realize the vast quantities involved. The English Channel is not a specially rich fishing ground, but calculations based upon the annual phosphate cycle show that the minimum value for the phytoplankton crop is about 1,400 metric tons wet weight per square kilometre each year[2]. The annual phosphate cycle involves the complete removal of this substance from the surface waters and a lesser removal in the deeper water, on account of the reduced illumination. But under each square metre the water column yields to vegetation

about 1 gm. of phosphorus, equivalent to about 7 gm. of calcium phosphate. Thus each square kilometre of sea has an annual turnover of about seven tons. To put any appreciable fraction of this quantity into the English Channel would involve a vast expenditure. Moreover, such addition would soon be dissipated into the ocean.

H. G. Wells is right in laying emphasis on the importance of phosphorus in limiting the fertility of the ocean, but his recent statement[3], that though "fisheries intercept a fraction of this phosphorus, the greater part of it forms insoluble compounds with other substances, bones, shells and so forth, and sinks slowly into the abyss beyond recovery", is incorrect. Actually the phosphate taken up is largely regenerated by excretion and decay; also the vertical circulation of the water column, which begins as the surface cools in autumn and continues until spring, brings phosphate and other nutrient salts to the well-illuminated regions again. A certain amount does sink to the abysses of the ocean. But much of this is brought up again when the oceanic currents impinge on banks and continental shelves. In this circulation, drainage from the land plays a very small part and cannot possibly account for differences observed between one year and another in such a body of water as the North Sea.

Phosphate is, of course, only one of the plant nutrients that would require to be added.

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Sept. 22.

[1] Ritchie, J., *Nature*, **154**, 275 (1944).
[2] Atkins, W. R. G., *Science Progress*, No. 106 (Oct. 1932).
[3] Wells, H. G., "Man's Heritage" (London, 1944).

## Temporary Ponds, a Neglected Natural Resource*

NATURAL pools which contain water for a few months in spring, and are dry for the remainder of each year, are found in many parts of the world. I have examined them in Great Britain, Denmark, Sweden, Siberia[1], Canada[2], Australia and Africa. In the past little attention has been paid to ponds of this kind, except by specialists. Since they are potentially useful to man a short account of them may be of interest.

The annual history of a temporary pond in the north temperate and sub-arctic zones is as follows: With the coming of spring, and the melting of the snow which has accumulated during the winter, water collects in shallow grassy depressions and remains there for two months or more. A large number of invertebrate animals emerge from the resting condition in the soil on the bottom of the pond site, and become active within a few hours of the filling of the pool. Some animals, such as the Entomostraca, over-winter as eggs, while others, including the snails, spend the winter in the adult condition. Within one month of the formation of the pond each spring, a very great abundance of life of many kinds is found in the water, and it is in this that the usefulness of these habitats lies. When the pond dries in early summer the aquatic fauna and flora resume a resting condition, and the pond site becomes a land habitat. Because of the presence of the excrement of the water animals, the pond sites are well fertilized, and therefore support a luxuriant growth of land plants during the terrestrial phase. The leaves and stems of these land plants serve, in turn, the following spring, as food for the aquatic animals, and in that manner fertilize the aquatic phase of the pool.

In at least one respect the immediate utilization of temporary ponds is possible. In the year 1928 I was engaged in scientific work at a fish hatchery on Lake Winnipegosis, in central Canada. At this place there was need for the feeding of the fry of whitefish (*Coregonus clupeformis*) before they were planted in the lake, in order that they should have a surer start in life; in other words, in order to reduce the wastage among the fry planted in spring when there is little food in the lake waters. A suitable food supply for the fry was found in temporary ponds on shore near the hatchery. It might be assumed that once the warmer weather had come, there would be a development of fish food in the waters of the lake at an equal rate as in the temporary ponds on the shore. In practice things do not happen in that way. In the lake there is a time-lag, due in the first instance to the fact that before the biological food-producing processes can really get under way two to three feet of ice must be melted by the sun. In contrast to this, there is a very rapid development of many organisms in the temporary ponds, because those sites have been dry during the winter and so have no covering of ice; in practice it was found that the collection of plankton and organic detritus in the temporary ponds, and the feeding of it to whitefish fry, is feasible, and results in the rapid growth of the fry.

Taking a long view, it is possible to think of the efficient utilization of the plant and animal proteins and carbohydrates which are available in temporary ponds in a rationalized agriculture. Under those conditions an aquatic crop, such as plankton or fishes, could be reaped from a given piece of ground, and be followed by a field crop, such as oats. A rotation of that sort is said to be followed in carp ponds in Central Europe. Another possibility is that the site, after the drying of the pond, could be used for intensive protein-rich grazing.

In many parts of the world temporary ponds are undesirable as being a wasteful hindrance to the agriculturalist, or they may be dangerous, as breeding places of disease-carrying mosquitoes and snails. The purpose of the present note is to point out their useful possibilities. In other words, temporary ponds, so often regarded as a nuisance, are in reality a neglected natural resource.

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Aug. 26.

[1] Mozley, Alan, *Trans. Roy. Soc. Edin.*, **58**, 605 (1935).
[2] Mozley, Alan, *Amer. Nat.*, **66**, 235 (1932).

* Published with the permission of the Medical Director, Colony of Southern Rhodesia.

## Surface Area of Small Objects

THE determination of the surface area of objects such as small particles or stones is of importance in many fields of research. These particles are usually convex in shape, but it seems that the mathematical theory of convex bodies is not widely known among experimental workers in this subject.

If a body is convex and has area $A$, it was proved by Cauchy that $A$ is equal to four times the mean of the area of the projection of the body on a plane for all orientations of the latter. This result has a limited application in the estimation by photographic or photometric means of the average surface area of a number of small particles suspended in a liquid. With larger particles such as stones, however, it suggests that the area of projection should be measured in a number of different directions by some such optical method. The average of these multiplied by four will give the surface area. In order to give equal weight to each observation it is desirable to choose the directions of projections to be those of the normals to a dodecahedron or an icosahedron.

The question then arises as to how good an approximation this is to the true mean. If $A$ is the true area and $A_1$ the area estimated by this method

$$0{\cdot}918 \leqslant \frac{A_1}{A} \leqslant 1{\cdot}079$$

for a dodecahedron, and

$$0{\cdot}955 \leqslant \frac{A_1}{A} \leqslant 1{\cdot}047$$

for an icosahedron. These limits are the approximate numerical values of certain trigonometrical expressions which can be evaluated exactly. They are, moreover, the best possible limits.

Proofs of the above results and some analogous theorems will appear in the *Annals of Mathematics*.

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## A Solar Halo Phenomenon

A DISPLAY of mock suns was seen here on the morning of August 9. Descriptions of similar displays seen at Cambridge and Godalming have been published[1] and these notes are supplementary to them.

The Farnborough display occurred in cirrus caused by aircraft trails at a height of 20,000 ft. At 12.15 a.m. (D.S.T.) it consisted of a complete parhelic circle, about one third of a complete tangent arc, left-hand and right-hand coloured parhelia near the 22° halo, two white parhelia situated on the parhelic circle and an anthelion. The colours were exceptionally brilliant.

The shape of the tangent arc was similar to that expected theoretically[2] for the sun at an altitude of 48° 07′ (its altitude at 12.15 a.m.). The colour bands in the left-hand parhelion were not perpendicular to the parhelic circle, but were inclined to the vertical at an angle of about 30°. They also extended slightly below the parhelic circle in a manner similar to the arcs of Löwitz. Some photographs taken by Mr. Brock show this inclination. They were made on Ilford Standard Panchromatic film with a tri-red filter: the range of wave-lengths recorded was from 5800 A. to 6700 A. A measurement on the best of the photographs gives, as the distance from the inside of the 22° halo to the inside boundary of the left-hand parhelion, 8° 44′ ± 30′ (extreme error). This distance has been calculated to be 9° 31′, assuming a refractive index of 1·307 for ice (corresponding to a temperature of − 10° C. and a wave-length of 6700 A.) and a solar altitude of 48° 07′. As it has been assumed that the sun is a point source, the agreement seems satisfactory.

The bands seen by Mr. Archenhold were also seen here; but according to our notes they were coloured, even when they passed through the sun. This indicates a diffraction origin for the colours. Unfortunately, it was not noticed whether the red or violet was nearer the sun; such an observation would have distinguished a refraction origin from a diffraction origin. We think that Mr. Archenhold's explanation is too simple, since it is geometrically impossible for a collection of reflecting and refracting elements between earth and sun to produce a straight band of light not passing through the sun, except for unlikely distributions of orientation.

It is evident that knowledge of atmospheric optics is still in an elementary state, and that many more careful (preferably photographic) observations are required. That England is not an unsuitable country for these observations is shown by the fact that, during the five weeks following the display, we have seen fifteen 22° solar halos, three brightly coloured parhelia, one isolated upper tangent arc (probably often mistaken for part of a 22° halo) and one 17° solar halo.

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[1] *Nature*, 154, 433 (1944).
[2] Pernter-Exner, "Meteorologische Optik".

## Prof. A. E. Conrady

I AM indebted to Mr. Cyril Young, of Sir Howard Grubb, Parsons and Co., Ltd., for directing my attention to a mis-statement in my obituary notice of the late Prof. Conrady[1]. I had been informed from a source which I believed trustworthy that, prior to the War of 1914–18, the periscopes fitted to British submarines had been obtained from foreign sources. Mr. Young, supported by other correspondents, assures me that almost all the periscopes of this period were made by the firm of Sir Howard Grubb and Sons, Ltd., in Dublin; and this firm produced the majority of the periscopes used during the War. Even before 1914, periscopes were the main product of the firm, though it was probably better known in scientific circles for its astronomical telescopes. Sir Howard Grubb took out a number of patents in connexion with submarine periscopes from the year 1901 onwards. The firm's workshops were removed from Dublin to St. Albans when the enemy submarine menace became acute.

This does not, of course, detract from the merit of Prof. Conrady's original work in the design of such complicated systems (his designs were not of the 'Grubb' type) and his efforts, together with those of the optical staff of the National Physical Laboratory, Messrs. W. Watson and Sons, Ltd., and Messrs. Kelvin, Bottomley and Baird, Ltd., must have contributed very largely to the adequate supply of these essential parts of submarine equipment. Their manufacture was later taken up by Messrs. Barr and Stroud, Ltd.

It is clear that Great Britain owes a great debt to the late Sir Howard Grubb in this connexion.

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[1] *Nature*, 154, 173 (1944).

# THE BEECH TREE

By ALEXANDER L. HOWARD

Hinc olim juvenis mundi melioribus annis,
Fortunatarum domuum non magna supellex
Tota petebatur ; sellas, armaria, lectos,
Et mensas dabat, et lances, et pocula Fagus.

Hence, in the world's best years, the humble shed
Was happily and fully furnished :
Beech made their chests, their beds, and the join'd-stools :
Beech made the board, the platters, and the bowls.
COULEIUS.

JULIUS CAESAR, after visiting Britain, returned home and reported that he had seen vast forests containing oak, ash, elm, and other trees in great abundance, and as he mentioned the trees by name, omitting the beech, it was thought that this tree was not indigenous to the country. C. A. Johns suggests that like some other explorers Julius Caesar was given to exaggerate the importance and extent of his travels, and conveyed the impression that he had penetrated farther into the country than was actually the case. Since he only traversed part of Sussex and Kent, and was in England only a few days, his report was of little account. Elwes, in "Timbers of Great Britain and Ireland", dismisses the subject once and for all by his pronouncement as follows :

"The beech is indigenous to England. Remains of it have been found in neolithic deposits at Southampton Docks ; Crossness, in Essex ; in Fenland ; in pre-glacial deposits in the Cromer forest bed ; and at Happisburgh, Norfolk. Names of places of Saxon origin, in which the word beech occurs, are very common, as Buckingham, Buxton, Boxstead, etc. . . . The beech is not believed to be indigenous in Scotland and Ireland, and no evidence is forthcoming of its occurrence in prehistoric deposits in those countries."

Johns, telling a story which he considers may be a fabrication, says :

"Among the many anecdotes connected with the history of printing which have come down to us, that related by Hadrian Junius deserves to be noticed in this place. About the year 1441, Lawrence Koster, a citizen of Haarlem, 'walking in a suburban grove, began first to fashion Beech-bark into letters, which being impressed upon paper, reversed in the manner of a seal, produced one verse, then another, as his fancy pleased, to be for copies to the children of his son-in-law'. This hint he subsequently improved upon, and finally invented blocks of lead and tin, and printed books. Among his workmen was John Faust, who, having been initiated in the art, although sworn to secrecy, decamped, carrying with him his master's stock in trade, and set up as a printer on his own account at Mayence. I should add that, although many literary men have credited this account, it bears, on close examination, internal evidence of being a fabrication, either of Hadrian or his informant."

The beech tree (*Fagus sylvatica*) with a smooth green trunk and a massive crown, covered in the early spring with vivid light green leaves, which darken as the year advances, changing in the autumn to a golden tint, is one of the most beautiful of all our forest trees.

The shade which it provides has been gratefully accepted by all people for two thousand years, and probably longer.

Pliny says :

"There is a little hill named carne within the territorie of Tusculum, not far from Roman Citie side, clad and beautiful with a goodly grove and tuft of Beech trees, so even and round in the head, as if they were curiously kept cut and shorne artificially with garden sheares : . . . In it there was one especiall faire tree above the rest, which Pabienus Crispus ; a man in our daies of great authoritie . . . cast a fancie and extra ordinarie liking unto : insomuch as he was wont not onely to take his repose and lie under it, to sprinkle and cast wine plentifully upon it, but also to clip, embrace and kisse it other whiles."

Strutt says :

"The Beech will grow in the most stoney and barren soil. In sheltering exposed situations it is particularly desirable on account of its retaining its leaves until the very end of Autumn, and indeed many of them throughout the winter. Their delicate green gradually fading to a modest brown, then to golden orange and at last to the more appropriate red."

In France it has been no less highly esteemed. Elwes says :

"in the North of France it attains perfection and forms very large forests . . . the finest beech forest in France is that of Retz which contains 37,000 acres . . . the beeches contain 329,433 c. ft. of timber, and reach a height of nearly 150 ft. with clean stems of 80 to 90 feet. Their age in 1895 was 183 years, and they were considered (then) to have reached their maximum development."

Later he mentions one of the finest beeches in France called "La Bourdigalle" in the Forêt de Lyons, which is supposed to be 375–575 years old. It is generally considered that in England the beech tree lives for about 250–400 years, probably reaching its prime in less than 200 years, after which time it gradually declines, invariably, as in the case of many trees, becoming hollow.

Strutt mentions the King Beech, in Knole Park, which in 1830 was "105 ft. high, 24 ft. in girth at 13 ft.", and it is interesting that Elwes mentions the same tree as follows : "in 1905 100 ft. by 30 ft. in girth at 5 ft. It has the largest girth of any beech I know of now standing in England". Mr. Mason, kindly instructed by Lord Sackville, has sent me the following note under date of May 18, 1944, regarding this tree :

"The Beech is now very much the worse for wear, only one of the main arms now being left. I have measured this at 13 ft. and it measures 37½ ins. quarter girth (150 in. circumference), I have also measured the main bole at 5 ft. ; this now measures 32 ft. in circumference. The height of the remaining portion of the tree is about 90 ft. It is now in full leaf."

It is interesting to notice that Pliny, 1,500 years ago, records the practice of the Greeks and the Romans who found themselves unable to resist the temptation of carving their names on the beech trees, and that the same habit is continued up to the present day.

While the beech, with its dense overhead crown, affords a welcome shade and a cooler temperature on hot summer days for the traveller, it is a greedy occupant of the surrounding ground. Unlike the plane, and the alder, its dense shade prevents flowers or grass from growing under it. The only compensation is one of which advantage is taken by the more thrifty people in Europe, extending from France to the confines of Italy and Greece. This consists of the truffles and morels which thrive beneath the beech tree. In Germany and France these fungi are eagerly collected and form an important food. Truffles were originally valued in England, and dogs were especially trained for finding the fungus, which grows somewhere under the surface of the ground ; a practice which, of late years, seems to have almost completely disappeared. On

the Continent, especially France, pigs are still used for this purpose.

Johns, speaking of the truffle, says:

"It possesses a strong but agreeable smell, and is generally found by dogs and pigs trained to search for it: but, in those countries where truffles abound, in October (which is their season for ripening) all the inhabitants repair to the woods, slightly stirring, or rather scratching the ground in those places which experience points out to them as the most likely to contain the tubers. The high price of, and constant demand for truffles, both in France and other countries, renders this a very lucrative employment, and experienced hunters are rarely deceived in the places where they make their search."

Berkeley quotes an instance of a poor crippled boy who could detect truffles with a certainty superior even to that of the best dogs, and so earned a livelihood. And as regards morels:

"In England they are comparatively rare, but Mr. Berkeley states that he has known them to be so abundant in Kent, as to be used for making a sort of catsup."

Forty-four years ago, in Norfolk, Sir Hugh Beevor took me with him on a search for truffles, which proved successful.

The great importance of the beech tree is not limited to its beauty and shade or even to its immense value for timber, but in addition it is recognized as one of the most important of those trees which help and foster the growth of all other forest trees. Step, who refers to the beech by the title of "Mother of Forests", very mistakenly says that "the timber has little importance", but he is quite correct in acknowledging "his heavy indebtedness to this Nursing Mother". Curiously, however, in later life, it is aggressive and overbearing, so that any woodland of mixed trees, even including oak, will be dominated and eventually expelled by the beech.

Of late years demand for this timber has exceeded all bounds, and among the forests and woodlands of England no tree has been more ruthlessly cut down.

Only a few years ago the country around High Wycombe seemed to provide an inexhaustible supply of beech trees suitable for chair and furniture manufacture. The industry is so old that it is difficult to discover when it first started, but until quite lately the early primitive pole lathe could be seen turning the chair legs in the beech woods, exactly as it was used hundreds of years ago. The pole lathe, together with the other tools employed in the work, was well illustrated in the issue of the *Woodworker* of May 1939. This consists of an upright or similar stake, to which a pole is attached at right angles. Thonging is attached to the pole and this is taken to the lathe. "The thonging passes round the work and causes it to revolve as the treadle moves downwards. The spring of the pole causes the treadle to be drawn up again ready for another stroke. The cut is made on the down stroke only." The supply of beech trees at High Wycombe which seemed at one time to be inexhaustible has vanished, and for some years past those engaged in the trade have had to go farther and farther afield for their timber, and even to import immense quantities from southern Europe.

Among many large sales, especially during the War of 1914–18 and up to the present, in every district where beech trees were available, one transaction stands out noticeably. This concerned one single sale of beech trees at Goodwood, when no less a sum than £55,000 was paid by the purchaser. I have been informed that most of this timber was sold in High Wycombe. I have also been informed that the destruction of these glorious woodlands was necessitated by the incidence of taxation to meet death duties. While this may be perhaps the largest single case on record, it is in no manner the only case, as the same thing has been happening in every part of Great Britain for a great many years past. Successive Governments, while wholly neglecting to make any provision for the reafforestation of the country, have at the same time brought about the deforestation year by year, so that to-day the situation has become dangerous to the welfare of the community.

Every account during 1,500 years has emphasized the usefulness and good qualities of the timber of beech, and for the last hundred years it has perhaps been only second or third in importance in our woodworking industries.

The wood is of a light brown colour, tough but soft, with a straight grain, easily worked, and presenting a smooth surface from both machine and hand tool, whether on the transverse, longitudinal, or across the grain. The extensive fine medullary rays, radiating from the centre to the outside, show when cut in multitudinous flecks. The shrinkage in seasoning is moderate, and with good air or kiln-drying presents even surfaces. Although beech when properly ventilated is fairly durable, if unventilated it rapidly decays, but under water, or ground where there is moisture, it is very durable. About thirty-five years ago, when the underpinning of Winchester Cathedral was necessary, round beech trees and oak were removed which were perfectly sound. The trees had been secured with pegs, some of beech wood, which were sound after more than five hundred years in position. Round piles of beech were taken up from the foundations of Waterloo Bridge, sound after sixty to seventy years of immersion in the bed of the Thames.

Beech has been a favourite wood with chair-makers for two hundred years and perhaps more. The higher-class makers working with walnut, oak, or mahogany, satinwood, etc., generally used beech for the frames; but it is noticeable that Chippendale never employed it. Many fine specimens of artistic design and clever craftsmanship have been lost as the beech framework used was attacked by the *Lyctus* or *Zestobium* beetles, or both, the framework rapidly turning to dust, and the chairs breaking up. The Master's chair, presented to the Glass Sellers Company in 1702, is a superb specimen constructed of walnut and beech; it is still in perfect preservation; but the beech framework had to be replaced this year to prevent collapse. Three other Jacobean chairs of exquisite English marquetry were similarly affected.

Immense quantities of the wood have been used for making a cheaper class of chair for halls, kitchens, and the well-known wheel-back chairs. This trade has been carried on extensively at High Wycombe and elsewhere. Innumerable articles have been made of beech, such as brush-backs, bowls, bread trenchers, and all kinds of domestic utensils. Many of these and also bedposts have been carved with the wheat-ear and other designs. Indeed, throughout the ages civilized man has recognized the merits and usefulness of this wood, for Pliny tells us:

"As touching the beech, the grain of it runneth rosse two contrarie waies like combe teeth; but in old time the vessels made of that wood, were highly esteemed. As for example Marius Curius having subdued his enemies, protested and bound it with an oath, That of all the bootie and pillage taken from them, he hath not reserved anything for himselfe, but only a cruet or little ewer of Beeche wood, wherewith he might sacrifice unto the gods."

Since the present War, the beech tree has come into prominence for the manufacture of ply-wood, with such success that the demand is likely to increase beyond expectation. The Ministry of Supply has now given instructions that all beech being felled in the British Isles shall first be inspected and suitable butts reserved for this purpose.

The very beautiful and ornamental tree generally known as the copper beech is a variety of the purple beech (*Fagus sylvatica* var. *purpurea*). The origin of this tree is doubtful. Elwes says:

"Mention is made of a beech wood at Buch, on the Irchel mountain in Zurichgau (commonly called the Stammberg) which contains three beech trees with red leaves, which are nowhere else to be found . . . and the legend is stated that according to popular belief five brothers murdered one another on the spot where the trees sprang up. Offspring of these trees were carried into a garden, where they still retained their purple colour."

As to the romantic origin above-mentioned, there may possibly be a difference of opinion. This tree can be found widely distributed and is highly prized in innumerable places throughout Great Britain and on the Continent. Its highly decorative appearance in parks and gardens should ensure its future success and planting. Within the last twenty-five years, on two separate occasions I have heard of the successful transplantation of two splendid fully-grown trees—a significant illustration of its appreciation by the respective owners. Elwes mentions that the largest tree which he had found was in the park at Dunkeld, Perthshire, which measured 86 ft. high, with a girth of 15 ft. 3 in.

Nor must we overlook among numerous varieties of this beautiful tree the fern-leaved beech, sometimes called the 'cut-leaved' beech, for which a number of different botanical names have been used, but which Elwes names var. ***heterophylla***: the origin of this variety is unknown. This tree is far too little known; but its ornamental character and the decorative beauty of its foliage should recommend it for more general cultivation.

## CHEMICAL RESEARCH IN THE U.S.S.R.

RECENT Russian publications received contain many papers of considerable interest dealing with chemical and physico-chemical subjects. Only a small number of them can be mentioned here.

Although polonium belongs to Group VI in the Periodic System, no compounds in which it shows a valency of six were known, although compounds of lower valencies have been described. A. G. Samartzewa[1] examined the co-precipitation of polonium with salts of telluric acid, containing 6-valent tellurium, and found that polonium crystallizes isomorphously with salts of orthotelluric acid. This suggests that polonium forms an ion $PoO_4''$ in which it is hexavalent.

The Debye formula for the dipole moment of a molecule in terms of the dielectric constant is restricted to gases and to very dilute solutions of polar substances in non-polar solvents. In the case of pure polar liquids the effective orientation polarization is less than the ideal orientation polarization,

$$P_i = \frac{4}{9}\pi N \frac{\mu^2}{kT},$$

which, if known, would give the dipole moment $\mu$. The difference is probably due to the internal local field in the liquid. J. K. Syrkin[2] has found two formulæ which give the relation between effective and ideal polarizations, from which the dipole moment $\mu$ for a pure liquid can be determined if its refractive index $n$, density $d$, and dielectric constant $\varepsilon$ are known ($N$ is Avogadro's number, $k$ is Boltzmann's constant, $M$ is molecular weight, $T$ is absolute temperature):

$$\frac{4}{3}\pi N \frac{\mu^2}{3kT} = \frac{(\varepsilon-n^2)(\varepsilon+2)}{(n^2+2)(2\varepsilon-1)}.$$

A formula for mixtures is also given, and can be used when the substance is soluble only in a polar solvent.

The relation between colour and structure of organic compounds has often been dealt with both theoretically and experimentally. A theory based on quantum-mechanical resonance was proposed by Sklar[3]. An increase in the number of conjugated bonds is accompanied by an increase in the number of resonance structures, which probably tells upon the absorption spectrum and colour. M. A. Kovner[4] has considered quantitatively the energy-levels and spectrum of hexatriene, and gets good agreement with the known absorption band.

Among the many suggestions for the structure of boron hydrides, one by M. E. Dyatkina and J. K. Syrkin[5] supposes that there are no single electron bonds but resonance between the states $>B^+$ and $>\overline{B}<$, and the structure of $B_2H_6$ is represented as follows. Two atoms of boron and four of hydrogen are in one plane and the remaining two hydrogens are on a line perpendicular to this plane and passing through the middle of the line B—B at equal distances from the plane. This model represents two distorted tetrahedra having a mutual edge. The model is discussed in the light of the electron diffraction measurements of Bauer and, in the opinion of the authors, is consistent with them. Structures for metal borohydrides are also proposed.

The mechanism of discharge of hydrogen ions has, as is well known, attracted a considerable amount of attention in recent years, and different theories have been proposed. A paper by A. Frumkin[6] gives a survey of his experiments. The lack of agreement of data on the over-voltage on mercury is traced to the deposition of impurities, especially near the electro-capillary maximum. The results with high current densities obtained by other workers are critically considered and shown to be really in agreement with Tafel's equation. Measurements with very low current densities are very difficult, on account of the possibility of depolarization by dissolved oxidants, and the danger of adsorption of surface-active substances. For very low current densities the time lag in charging the double layer also comes in. There is some disagreement with Bowden and Kenyon's results, but not much. The results with dropping electrodes are considered in detail. The shift of half-wave potential with concentration found by Tomeš was not confirmed. A very detailed discussion of the structure of the double layer is given, and, among other conclusions reached, it is shown that results cannot be explained on the assumption that the potential depends only on the distance from the mercury surface.

[1] *Compt. Rend., U.R.S.S.*, **33**, 498 (1941).
[2] *Compt. Rend., U.R.S.S.*, **35**, 43 (1942).
[3] *J. Chem. Phys.*, **5**, 669 (1937).
[4] *Compt. Rend., U.R.S.S.*, **35**, 51 (1942).
[5] *Acta Phys. Chim., U.R.S.S.*, **14**, 547 (1941); *Compt. Rend., U.R.S.S.*, **35**, 180 (1942).
[6] *Acta Phys. Chim., U.R.S.S.*, **18**, 23 (1943).

# WORK OF THE LA PLATA ASTRONOMICAL OBSERVATORY

BERNHARD H. DAWSON has a paper with the title, "Observaciones De Planetas y Cometas", published at the La Plata Astronomical Observatory, which deals with his observations during the years 1940–41 (*Obs. Ast. Univ. Nac. de la Plata*, **6**, No. 7). The work was carried out with the equatorial instruments of the Observatory, and the visual observations were effected with the filar micrometer of the refractor with aperture 433 mm., using a dark field illuminated with red light. A brief description of certain methods and precautions to ensure accuracy is given. On several occasions it was found necessary to use relatively faint stars as reference points owing to the limited field, but no difficulty was experienced in this procedure, thanks to the "Astrographic Catalogue".

Photographic observations during the first years of earlier observations at the Observatory were carried out entirely by means of the "Astrographic" objective, aperture 342 mm. and focal length 3,417 mm., but more recently the "UV" objective, aperture 160 mm. and focal length 1,500 mm., has come into general use. It was found that the smaller aperture was largely compensated by the greater clarity of the images, and in addition to certain advantages, its larger field is of assistance in the search for planets of uncertain position, and in other ways as well.

In the photometric work on Eros, compensation of half the apparent motion of the planet was effected during the exposures, so that the images of the planet should present the same aspect as those of the stars, and thus could be compared photometrically. Unfortunately, the atmospheric conditions were not favourable for this work, clouds intervening on many occasions. A table shows the positions of Eros during May 28–September 26, 1940, and another table supplies details of the photometric observations during June 11–August 23 in the same year.

Positions of Comets Cunningham, 1940 *b*, Whipple, 1940 *d*, van Gent, 1941 *d*, and Schwassmann-Wachmann, 1941 *f*, are also supplied for a number of dates.

Gualberto M. Iannini has published three papers with the titles, "Medidas Micrometricas De Estrellas Dobles"; "Posible Movimiento Rectilineo De β 311"; and "Una Nueva Determinacion De La Orbita De Ψ Argus" (*Obs. Ast. Univ. Nac. de la Plata*, **6**, No. 8). The first of these papers describes the author's measurements of double stars. The micrometer was used in connexion with the equatorial refractor, aperture 433 mm., and the measurements were generally made when the hour angle was less than two hours. Six readings of the position angle were taken, three with the eyes parallel to, and three with the eyes perpendicular to, the micrometer wires, thirty-six stars in all being dealt with. Details of the results are set out for each star in columns which supply the year and fraction of a year of the observation (1900 being taken as the basis), position angle observed, mean distance, etc.

The second paper deals with the possibility of rectilinear motion of the system β 311, the components of which are of magnitude 6·7 and 7·0. The equations expressing the movement of the system in right ascension and declination show that there is an annual relative movement of 0·0182″ in a direction 130·25° and a minimum distance of 0·336″, with an angle of 40·25° for the year 1941·5. A table gives the relation between observation and calculation, from 1875·92 to 1937·08, and with two exceptions, it shows that the hypothesis of rectilinear motion is satisfactory. A definitive solution of the problem, however, cannot be effected at present.

In the third paper the elements of the orbit of Ψ Argus are re-determined from forty-one observations. The companion having made considerably more than a revolution since its discovery in 1883·3, the two dynamical elements can be determined by means of a graphic method, and the other elements were obtained by the method of Zwiers. Residuals revealed the presence of a systematic error, and corrections were applied which gave a new orbit. It is interesting to know that Van de Bos had also revised the orbit and his results, not yet published, were brought to the notice of Iannini after the completion of his work. With the exception of *a*, the two sets of elements differ by amounts which do not exceed 2½ times Iannini's mean errors.

# MAN: THE FIRE-USING ANIMAL

ON March 8 last the Association of Czechoslovak Scientists and Technologists was addressed by Dr. G. W. Himus on "Man: The Fire-Using Animal". Although the lecture started with an account of the origin and the rise of the use of fire by mankind—or as suggested 'fuel squandering'—in the main it surveyed the present state of fuel supplies and prospective fuel technology in Great Britain. Noteworthy is the slowness with which Great Britain became conscious of the importance of efficiency in getting and consuming coal—doubtless owing to the abundance, high quality and cheapness of British coal together with the slender scientific outlook. Without this, waste cannot be recognized, still less corrected. Moreover, in some industries, the cost of fuel is a relatively small item of the cost of production and consequently failed to arouse the attention of the management.

Nevertheless, a time arrived when the importance of a more rational use of coal came to be recognized. It was even found worthy of a place in university studies—at Leeds in 1906, at the Imperial College in 1912, while the Fuel Research Board was established during the War of 1914–18. The two Wars which followed shook the complacency of the State and industry, by the scarcity and steep rise in prices, and in the present War, by the development of acute scarcity.

Although, during the past, knowledge of efficiency in the use of fuel has advanced, experience in the national campaign for fuel saving has revealed a lag in the application of this knowledge. The author illustrates the advance in fuel efficiency by the performances of large industries accustomed to employ considerable technical assistance. These include the public utilities, iron and steel industries and the coal mines. The net saving of coal of these in the period between the two Great Wars is estimated by the author to reach thirty-two millions of tons of coal per annum, while the total saving may be considerably higher. This is a very large quantity of fuel, to supply which would have been a great embarrassment to the Ministry of Fuel and Power to-day.

Some matters of importance, both topical and future, are examined. Emphasis is given to the need

for greater application of technical training for the smaller industrial units—possibly by co-operative effort. The sale of solid fuel in small quantities by weight without allowance for calorific value is criticized. It must, however, be recognized that there are peculiar difficulties, and in some countries solid fuel is sold by volume. The heating value of gaseous fuels in public supply can be easily controlled, whereas it cannot vary appreciably in the case of liquid fuels of given chemical character. Moreover, coal as mined contains variable proportions of incombustible matter, sometimes hard to separate. It is often overlooked that the cleaning of coal involves the production of considerable quantities of coal 'fines' or 'slurry' of little or no commercial value, while accumulations of small coal, if ignited, may become a public nuisance. For steam raising, it is considered possible that consumers will have to adapt themselves to the use of a lower grade of coal. Already the need for widening the range of fuel in use has caused official encouragement to be given to the installation of suitable mechanical equipment.

The lecture mentions a number of fuel problems still in the more speculative stage, and in all gives an interesting survey of the questions now in the minds of modern fuel technologists. H. J. Hodsman.

# FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

### Saturday, October 14

Association for Scientific Photography (at Caxton Hall, Westminster, London, S.W.1), at 2.30 p.m.—Mr. H. Emmett: "Cinemicrography of Crystal Growth"; Mr. R. McV. Weston: "Cinemicrography in Biological Research".

### Monday, October 16

Institution of Electrical Engineers (London Students' Section) (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—"Brains Trust" Meeting.

Association of Austrian Engineers, Chemists and Scientific Workers in Great Britain (at the Austrian Centre, 69 Eton Avenue, Hampstead, London, N.W.3), at 7.30 p.m.—Mr. E. Pribram: "Jet Propulsion, Rocket Propulsion".

### Tuesday, October 17

Institution of British Agricultural Engineers (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2 p.m.—Mr. Cornelius Davies: "Harvesting Machinery".

Society of Chemical Industry (Agriculture Group) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. H. C. Gough: "Soil Insecticides".

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. Innes H. Pearse: "The Health Centre and the Family".

Chemical Society, the Royal Institute of Chemistry, and the Society of Chemical Industry (Edinburgh Sections) (joint meeting with the Edinburgh University Chemical Society) (in the Medical Chemistry Lecture Theatre, The University, Teviot Place, Edinburgh), at 7 p.m.—Prof. G. F. Marrian, F.R.S.: "Some Aspects of Heroid Metabolism".

### Wednesday, October 18

Institute of Fuel (North-Western Section) (at the Engineers' Club, Albert Square, Manchester), at 2.30 p.m.—Mr. G. N. Critchley: "The Economics of Saving Fuel, with particular reference to the Insulation of Steam Ranges".

Institution of Electrical Engineers (Transmission Section) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. H. W. Grimmitt: Inaugural Address as Chairman.

British Association of Chemists (London Section) (at Wigmore Hall, Wigmore Street, London, W.1), at 6.30 p.m.—Discussion on "The Safeguarding of Key Industries" (to be opened by Mr. Norman Sheldon).*

Iron and Steel Institute (joint meeting with the Manchester Metallurgical Society and the Institute of Metals) (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Prof. H. W. Swift: "Deformation of Metals".

### Thursday, October 19

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Prof. Wilson Baker: "Non-benzenoid Aromatic Hydrocarbons" (Tilden Lecture).

Institute of Fuel (East Midlands Section) (in the Lecture Theatre of the Nottingham Corporation Gas Department, Parliament Street, Nottingham), at 3 p.m.—Dr. E. W. Smith and Mr. Theodore Turner, K.C., will speak at a Conversazione.

Society of Chemical Industry (Road and Building Materials Group) (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 5 p.m.—Mr. D. C. Broome: "The Substitution of Coal Tar Pitch for Asphaltic Bitumen in Building Mastic".

Society of Chemical Industry (Newcastle Section) (at the King Edward VII School of Art, King's College, Newcastle-upon-Tyne), at 5.45 p.m.—Mr. J. Brown: "Assay of Coal for Carbonisation Purposes".

### Friday, October 20

Institution of Electrical Engineers (Measurements Section) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. W. G. Radley: Inaugural Address as Chairman.

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. H. R. Ricardo, F.R.S.: "Applied Research" (Presidential Address).

North-East Coast Institution of Engineers and Shipbuilders (in the Lecture Theatre of the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6 p.m.—Annual General Meeting. Sir Summers Hunter: Presidential Address.

### Saturday, October 21

British Rheologists' Club (at the University, Reading), at 2.30 p.m.—Annual General Meeting. Discussion on "The Measurement of Tack" (Introductory Papers by Dr. N. A. de Bruyne and Dr. R. F. Bowles).

Sheffield Metallurgical Association (at 198 West Street, Sheffield, 1), at 2.30 p.m.—Mr. A. Preece: "The Oxidation of Steels in Furnace Atmospheres".

Quekett Microscopical Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. Nellie B. Eales: "Some Aspects of the Malaria Problem".

# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer (full-time) in Chemistry, and a Lecturer (full-time) in Engineering for Day and Evening Classes—The Principal, College of Technology and Commerce, The Newarke, Leicester (October 18).

Mathematics Master for the Junior Day Technical School for Boys—The Principal, Wimbledon Technical College, Gladstone Road, London, S.W.19 (October 20).

Mathematics Master in the Bristol Junior Technical School—The Chief Education Officer, 2 Cecil Road, Clifton, Bristol, 8 (October 21).

Lecturer (full-time) in Engineering Subjects in the Medway Technical College, Gillingham—The District Education Officer, Fort Pitt House, Rochester (October 21).

Assistants at the Fuel Research Station, Blackwall Lane, Greenwich, London, S.E.10, for abstracting and translating scientific literature relating to Fuels (candidates should have qualifications in one or more of the following subjects: Chemistry, Physics, Engineering; together with a good knowledge of French and German)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2985.A) (October 21).

Experienced Organic Microanalyst—The Professor of Organic Chemistry, Imperial College, South Kensington, London, S.W.7 (October 21).

Electrical Engineer to the Borough of Darwen—The Town Clerk, Town Clerk's Office, Darwen (endorsed 'Electrical Engineer') (October 23).

Works Engineer for development of a permanent Electro-chemical Plant in South Wales—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2303.XA) (October 23).

Borough Electrical Engineer and Manager to the Borough of Willesden—The Town Clerk, Town Hall, Dyne Road, Kilburn, London, N.W.6 (endorsed 'Borough Electrical Engineer and Manager') (October 23).

Principal of the Blackburn Municipal Technical College, and Head of the Textile Department—The Director of Education, Education Office, Library Street, Blackburn (October 23).

Lecturer in Mathematics, a Lecturer in Physical and Inorganic Chemistry, and a Lecturer in Mechanical Engineering—The Principal, Brighton Technical College, Brighton (October 23).

Food Chemist in Food Standards and Labelling Division, Colwyn Bay—The Ministry of Labour and National Service, Central Register, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.3042.A.) (October 24).

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## CONTENTS



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# THE UNITED NATIONS: A PROPOSAL FOR INTERNATIONAL SECURITY

FOR more than five years of war, the conditions of peace and the means and organization to ensure peace have been discussed with a thoroughness and earnestness accentuated if anything by the vicissitudes and ordeal through which the United Nations have passed. The causes of the failure of the League of Nations have been probed and analysed dispassionately, and the reasons for the comparative success of other international agencies such as the International Labour Organisation have been scrutinized with the view of throwing the fullest light on the principles to be served in any subsequent attempt to build a new world organization. Even at the end of 1939, serious studies were being initiated by Political and Economic Planning and by the Royal Institute of International Affairs into the various aspects of international co-operation. The quality of the resultant studies and much of the voluminous literature of the ensuing years, with such outstanding books as Prof. E. H. Carr's "Conditions of Peace", Lord Cecil's "A Great Experiment", Mr. Harold Butler's "The Lost Peace" and Mr. R. M. Reyner's "The Twenty Years' Truce", has reached a level that provides solid ground for believing that a much more scientific approach to the whole question of world organization has become possible.

Moreover, it is realized that there are lessons to be drawn from the Armistice of 1918, and the consequences which flowed from the premature termination of the organizations set up to forward the Allied war effort, such as the Inter-Allied Shipping Control. That realization is reflected in an obvious desire to see that such agencies as the Combined Raw Materials Board, the Middle East Supply Centre and the like, shall be used to serve the purposes at least of the interim period of re-settlement and reconstruction.

That much can be discerned as a matter of general agreement, whether or not we accept in full the arguments of the functional school of thought, as represented by Prof. Mitrany, who see in the development of functional services to meet specific ends and needs the most hopeful way to build up a world organization in which resort to war is obsolete. Others, such as the American spokesmen Mr. Walter Lippmann and Mr. Sumner Welles, impressed by the Atlantic Community or by Pan-America, find the solution in regionalism; while others again, such as Sir John Fisher Williams, insist on the importance of dealing with the causes of international differences by peaceable discussion before they become critical, and on limiting action to what is possible at the present stage of human development. Another school of thought urges federation as the solution, either on the lines outlined by Clarence Streit in "Union Now" or in a more limited form by Mr. Lionel Curtis. Others again, recognizing that an international organization which is to achieve its purposes must have strength to give effect to its decisions, have

concerned themselves with the ways and means of putting teeth into the Covenant.

In contrast to the discussions on world organization earlier in the War, there has been a significant tendency of late to reconsider the verdict on the League of Nations, and to attribute its failure not to the machinery but to the lack of drive and sincerity behind it. Writing to Lord Cecil on his eightieth birthday recently, the Prime Minister said: "This war could easily have been prevented if the League of Nations had been used with courage and loyalty by the Associated Nations", and went on to speak of acting "in accordance with the spirit and principles of the League, but clothing those principles with the necessary authority". Any workable system must be a compound of realism and idealism, and in a problem of such complexity all simple formulæ are rightly suspect.

The tentative proposals for the establishment of a general international organization under the title of "The United Nations" which have now been published as an outline agreement reached between the delegations of Great Britain, the United States, the U.S.S.R. and China at Dumbarton Oaks, Washington, during August 21–October 7 on the maintenance of peace and security after the War fairly reflects this tendency. Superficially at least, they bear a marked resemblance to the old League of Nations. Membership of the organization is open to all peace-loving States, and the organization, like the League of Nations, will possess four principal organs: a General Assembly, a Security Council, an International Court of Justice and a secretariat, with such subsidiary agencies as may be found necessary. All members of the organization will be members of the General Assembly. While the General Assembly may initiate studies and make recommendations for promoting international co-operation in political, economic and social fields or for co-ordinating the policies of agencies in such fields, it will not consider concurrently any matter relating to the maintenance of international peace and security which is being dealt with by the Security Council. Again, while it may consider the general principles of co-operation in this field, questions in which action is necessary will be referred by the Assembly to the Security Council before or after discussion. These are important differences from the League's constitution.

The Security Council is to consist of eleven members, five permanent and six elected by the General Assembly for a term of two years, three retiring and not being eligible for immediate re-election. The permanent members designated are the United States, the United Kingdom, the Union of Soviet Socialist Republics, China, and, in due course, France. This Security Council will be charged with the primary responsibility for the maintenance of international peace and security.

Some of the draft proposals recall in substance the articles of the Covenant, but there are notable omissions and additions. The Security Council is empowered to investigate any dispute or situation which may lead to international friction or give rise to a dispute, in order to determine whether its continuance is likely to endanger the maintenance of international peace or security, and any State, whether a member or not, may bring any such dispute or situation to the attention of the General Assembly or of the Security Council. But while Article 2 of the Covenant is thus shadowed, there is nothing that corresponds with Articles 13 and 15. The Security Council may call upon the parties to such a dispute to settle their differences in accordance with their obligation under the Charter by negotiation, mediation, conciliation, arbitration, judicial settlement or other peaceful means, as contemplated by Article 12, but neither the Security Council nor the General Assembly is charged with the duty either of conciliation or of investigation and report.

It is in the section which replaces the sanctions clauses of the Covenant that the major departures from the old League of Nations appear. The Security Council, having determined the existence of a threat to the peace, is empowered to determine what diplomatic, economic or other measures not involving the use of armed force are required to maintain or restore peace and security, and to call upon members of the organization to apply such measures. If the Security Council considers such measures inadequate, it is also empowered to take such action by air, naval or land forces as may be necessary. To that end, all members of the organization, not merely the members of the Council, are to accept the obligation not only to apply the diplomatic, economic and like sanctions but also "to make available to the Security Council, on its call and in accordance with a special agreement or agreements, concluded among themselves, armed forces, facilities, and assistance necessary. . . ." In particular, for urgent military measures, there are to be "held immediately available by the members of the organisation national air force contingents for combined international enforcement action".

Plans for the application of armed force are to be made by the Security Council with the assistance of a Military Staff Committee, responsible for the strategic direction of the armed forces placed at the disposal of the Security Council. This Committee will consist of the chiefs of staff of the permanent members of the Security Council or their representatives, and is clearly a continuation of the present Joint Chiefs of Staff Committee, although any member not permanently represented on the Committee may be invited by the Committee to join it. The main responsibility for the exercise of force is placed squarely on the shoulders of the Great Powers, who alone possess the necessary resources to wage war effectively.

Beyond these measures, the Charter contemplates the fostering of regional arrangements for the maintenance of peace and security and the settlement of local disputes, and the Security Council will also utilize such regional arrangements for enforcement action under its authority where appropriate. As already indicated, there is to be an International Court of Justice, constituted and functioning either by a new statute, or by a continuation or modification of that constituting the present Permanent Court of International Justice. Similarly, the clauses

relating to the secretariat are obviously modelled on Geneva experience.

In place, however, of those Articles of the Covenant relating to social activities and international bureaux, there is a separate chapter in the proposed Charter, covering international economic and social co-operation. Here it is declared to be the purpose of the organization to facilitate solutions of international economic, social and other humanitarian problems, and promote respect for human rights and fundamental freedoms, with the view of creating conditions of stability and well-being which are necessary for peaceful and friendly relations among nations. The responsibility for the discharge of this function is vested in the General Assembly, acting through an Economic and Social Council consisting of representatives of eighteen members of the organization, and elected for terms of three years by the General Assembly.

This Economic and Social Council would be empowered to make recommendations on its own initiative in international economic, social and other humanitarian matters, and to receive and consider reports from the related specialized organizations and co-ordinate their activities. It would establish an economic commission, a social commission and such other expert commissions as may be required. The Council would be provided with a permanent staff constituting part of the secretariat of the organization.

The proposals thus outlined are loosely worded and there are other questions reserved for further consideration besides the thorny one of voting procedure in the Security Council specifically mentioned. They represent a framework and not a completed edifice like the League Covenant. Within that framework, it should be possible to build a practical edifice, though in some respects the proposals are so wide that it is not easy to discern even yet the precise shape of the organization to be hammered out in due course by the drafting committee and by that public debate which, as Lord Cranborne has indicated, the Government has invited in publishing the proposals. It is essential, as was emphasized by Lord Cranborne, that the people of Great Britain and of other countries should understand the reasons for the main provisions of a peace settlement and how it came to be made, and that they should accept, and know that they are accepting, a share of the responsibility for these arrangements and for maintaining them in the future as the agreed means of preserving peace and prosperity in the world.

Conversely, it is true, as recent debates on the German problem have indicated, that whatever settlement is reached must be one which will command the support of British opinion not merely to-day but in twenty or thirty years time. From that point of view it is important to note that the proposals embody much that is common ground. They follow indeed so much on the lines of the League of Nations that at first sight it is difficult to see why the Covenant of the existing League could not be re-shaped for the present purposes. It can at any rate be said that it is proposed to utilize past experience to the full and to build on existing structures so far as possible. The scheme outlined under the Economic and Social Council should provide, for example, for continuing the work of the International Health Organization, and other technical organizations of the League.

Furthermore, the proposals meet the point on which there is now general agreement, that any system which is to be workable must take account of the special status of the Great Powers and not pretend, in the name of collective security, to diffuse the responsibility for questions of war and peace among those who could not execute the decisions. Next, they meet the argument that a system to engage the idealism of mankind must be designed to solve the great majority of questions by free agreement and without the use of force. Clearly the proposals now drafted could cover both the utilization for peace-time purposes of the regional and functional organizations established to serve the present purposes of the United Nations and provide for their effective co-ordination. There is at least a hint that the organization will ultimately address itself to the positive side of security—the elimination of the causes of war themselves by the evolution of a science of peaceful change—and it may well be that in the end the Economic and Social Council rather than the Security Council will be the important organ.

There are yet many points to be cleared up. National sovereignty still figures prominently, and with the reservation on internal causes of dispute may well be a source of danger pending the further evolution of international law or the overlaying of the conception of security on frontier lines with a natural growth of common activities and administrative agencies which make frontier changes meaningless.

Meanwhile, it should be remembered that, like the Bretton Woods and Hot Springs Conferences, that at Dumbarton Oaks stands for one of a series of conferences designed to ensure that the United Nations remain united in peace. It must not be forgotten, for example, that no machinery of security will withstand the strain of mass unemployment, falling standards of living and social and economic chaos. However excellent in themselves the proposals of the Dumbarton Oaks Conference may be, their success will depend on the sincerity and faithfulness with which the policies of the United Nations Relief and Rehabilitation Agency and of the Food and Agricultural Organization initiated at Hot Springs are carried out, and on the removal of trade barriers and the harmonization of national policies to maintain a high and stable level of employment adumbrated at Bretton Woods. It will also depend, too, on how far and thoroughly the implications of the proposals are understood by the people of Britain and of the other United Nations, and the extent to which they are prepared to make the sacrifices necessary to establish an effective organization through which the spirit of scientific inquiry can enter fields where prejudice and selfishness and the habit of judging in one's own cause have too long reigned supreme.

## SNAKES OF INDIA

**The Fauna of British India, Ceylon and Burma, including the whole of the Indo-Chinese Sub-Region**

(Published under the patronage of the Secretary of State for India.) Edited by Lt.-Col. R. B. S. Sewell. Reptilia and Amphibia. Vol. 3: Serpentes. By Malcolm A. Smith. Pp. xii+584. (London: Taylor and Francis, Ltd., 1943.) 45*s*.

HERPETOLOGISTS, especially those in India, will greet with warm satisfaction the appearance of a new book dealing with the anguifauna of the Indo-Chinese sub-region. The revision of previous work has been eagerly awaited for some years, as nothing has appeared in book form dealing with this specified area since Boulenger's "Catalogue" in 1896.

The work of revision has been entrusted to Dr. Malcolm A. Smith, and nobody better qualified could have been chosen. With his high scientific attainments, he combines the unusual distinction of having by a long residence in Siam been brought into intimate association with living snakes in their natural haunts, a distinction not usually enjoyed by writers of such books. He has made an exhaustive survey of the notes and papers that have been contributed to various journals by various writers during the last forty or so years, subjected them to a searching analysis, and corrected nomenclature where necessary. In addition he has reviewed the work of every earlier herpetologist, and incorporated the result of their researches with his own.

The first thirty-five pages of this quarto volume are introductory; the later pages up to 526 are devoted to the description of some 389 species, with useful keys to assist identification. Valuable appendixes follow dealing with the Hardwicke and Russell collections, and there is a very complete list of the bibliography on the subject.

The introduction is crowded with facts, and the information therein contained should serve to satisfy the curiosity of the most inquisitive mind. The subject-matter includes numerous anatomical considerations, evolution, classification, geographical distribution, habits, etc. Each topic is considered under a separate heading, and the facts dealt with tersely but adequately. The grain of the matter is there divested of its husk.

In the realm of anatomy, special remark is called for concerning the curious and complex system of facial and salivary glands, well illustrated on pages 12 and 13, with further remarks later in the text; also the variously disposed and mysterious system of subcutaneous glands, elaborated still further in the text under individual species, and well illustrated. All this information is entirely new, and accounts for the silence on the subject of previous authors.

Another matter now introduced to our notice concerns the male genitalia. These very remarkable twin organs have been little studied in the past, but remarks accompanied by good illustrations showing them *in situ* in their quiescent state are furnished.

There is no reference to the occipital condyle. This process, so vastly different in the lowly organized families such as *Uropeltidæ*, compared with the more highly organized, deserves special attention and may prove of some influence in the separation of families.

I have scanned the pages of this book closely, and find that no branch of the subject has received more favoured attention than another. Every matter has been most thoroughly examined and treated. The scientific man will appreciate and praise every part of the volume. The unscientific reader will find the introductory part intelligible and richly informative.

I am in accord with nearly all Smith's views and his corrections of others' work, including my own. He has very rightly rigidly observed the law of priority, which some of his predecessors have not respected. As a consequence the multiplicity of changes in nomenclature is truly deplorable. Had all previous authorities been equally meticulous, the necessity for reviving earlier names that should never have been discarded would not have arisen; further, workers in this field of zoological research would have been spared the vexation and inconvenience engendered by abandoning names with which they had long been familiar, and adopting new ones.

The substitution of *Leptotyphlopidæ* for the family *Glauconiidæ*, and of *Anilidæ* for *Ilysiidæ* will not be challenged; about the abolition of *Amblycephalidæ*, more hereafter.

At least twenty-three of the eighty-nine genera dealt with have had their names altered from those used in Boulenger's "Catalogue"! I have critically examined these, and regard the grounds for change unassailable in every case, most of them depending on the operation of the law of priority. They are too numerous to review in detail, but a few demand special remark. It has long been apparent that the genera *Coluber*, *Zamenis* and *Ablabes* (now *Opheodrys*) needed revision, and I think the changes now effected are well founded and therefore should escape alteration by future taxonomists.

The genera *Ptyas* and *Elaphe* have been revived at the expense of *Zamenis* and *Coluber*, and there has been some reshuffling of other species. The restoration of *Ptyas mucosus* to generic rank will not be contested. I had hoped to see this species treated somewhat differently. It is unique in the arrangement of its scale rows, of which seventeen in the anterior half of the body are reduced to sixteen shortly behind. This reduction is effected by the disappearance of the uppermost costal row on the left side. A similar reduction of scale rows, from seventeen to sixteen, and by the same method, occurs in all the species of *Zaocys*, but in the neck instead of the body. This, together with other very close affinities, would warrant the abolition of the genus *Zaocys* and the inclusion of its species in the genus *Ptyas*. The affinities of *korros* and *mucosus* are not so marked as those of *mucosus* with the species of *Zaocys*, and warrants the exclusion of *korros* from *Ptyas*. *Simotes*, separated from *Oligodon* on false claims, has been very properly suppressed.

*Ahaetulla*, a revival on grounds of priority, embraces and supersedes the two genera *Dendrophis* and *Dendrelaphis*, separated on insufficient grounds.

The revision of the sea-snakes and the amended classification constitute a great advance. The arrangement of this group is now intelligible to all, where previously it was in part unintelligible even to experts. The bewildering confusion that previously existed has been swept away and order established where chaos reigned. The basis on which the classification now stands is sounder than ever before. The genus *Distira*, based on false premises, has been abolished, and eighteen species recognized by Boulenger have been placed with *Hydrophis*, which, in spite of this increase, now only numbers fifteen species where Boulenger recognized twenty-two. The recognition of the genera *Kerilia*, *Præscutata* and

*Microcephalophis* and their isolation from *Hydrophis* will receive general approval. This good work might have been further extended, and genera multiplied at the expense of *Hydrophis*.

*Hydrus platurus* was the name fixed by international approval some twenty or so years ago for the species now designated *Lapemis platurus*, and it will be regretted that after such an authoritative ruling the generic name has not been upheld.

Any disturbance of the admirable treatment of the family *Colubridæ* by Boulenger is to be deprecated, except in the ranks of genera and species. Such, for example, as the elimination of the proteroglyphs from that family, and their elevation to the dignity of independent families. I regard this as unnecessary. To be consistent, the opisthoglyphs deserve similar treatment and equal rank, which is not conceded to them.

Again, the association of the aglyphous African *Dasypeltis* with the opisthoglyphous Indian *Elachistodon* and their inclusion in one family will be severely criticized. I prefer Boulenger's views. If this arrangement stands, each deserves to be placed in an independent sub-family.

The abolition of the family *Amblycephalidæ* is a bold departure from previous views. The six species that used to figure in that family have now been deposed from the exalted position they occupied above the family *Colubridæ*, and are placed on a low rung of the *Colubridæ* ladder. *Haplopeltura* retains its title, but *Amblycephalus* has been superseded by its earlier title *Pareas*. The dentition of the latter is distinctive, and differs from any species of *Colubridæ* that I have dissected. The cephalic lepidosis is remarkably distinctive, and also differs from that of any other Colubrid known to me.

The generic name of the cobra should be altered to *Naga*. It was clearly the intention of Linnæus to attach to it the name by which it is universally known to the natives of India—"nag" (pronounced narg). It is probable that this information was conveyed by letter and that he mistook the 'g' for a 'j'. *Naja*, and still less the *Naia* of some authors, have no meaning. Under the amended and more elastic rules of nomenclature referred to on page 33, such an alteration would be permissible. The suggestion might well be referred to the next session of the International Committee of Nomenclature.

No remark as to location accompanies the list of Russell's types on page 531. I examined them in the Museum of the Royal College of Surgeons. Their transference to South Kensington would make them more accessible, and they would fittingly rejoin Russell's collection of skins already there.

I am glad to note that doubts raised as to some of Beddome's localities have been upheld, and in consequence the spurious localities rejected, and habitat appropriately amended, as instanced in the case of *Oligodon splendidus*.

The map at the end of the book would be more useful if the boundaries of the tracts had been demarcated.

The artist deserves unstinted praise for the excellence of her work. The figures depicting the dorsal and ventral markings especially are very beautifully executed. The multiplication of such figures would have been advantageous.

Dr. Smith has quoted me extensively, and paid a very generous tribute to my work. He has also corrected me freely and deservedly. The fact that in compiling his book he has had close access to the national collection at South Kensington, with the many types it contains, and also a library to consult comprising the whole of a voluminous bibliography combine to make his opinions far more authoritative than mine.

Finally, a few discrepancies have been noticed. *Dasypeltinæ* should be excluded from the synopsis of the sub-families of *Colubridæ* on page 114 so as to agree with the family status on page 403. *Oligodon subgriseus* on page 531 should read *O. tæniolatus* to agree with page 223. *Callophis trimaculatus* on page 532 should read *C. melanurus* to agree with page 420.

F. WALL.

# CEREALS AND HISTORY

**Six Thousand Years of Bread**

Its Holy and Unholy History. By H. E. Jacob. Pp. xv+399+8 plates. (Garden City, N.Y.: Doubleday, Doran and Co., Inc., 1944.) n.p.

IN describing the history of bread, Mr. Jacob has, in effect, attempted to explain the political and economic history and social structure during the eras of their political ascendancy of ancient Egypt and Greece, the Roman Empire, Europe and the United States in terms of religion and of the cultivation of cereals. The result is, however, too simple to be of much interest to historians, and its value for lay readers, for whom it is obviously intended, is reduced by the paucity of dates.

Generally speaking, bread is made only from wheat and rye, and it is with these two cereals that the book is therefore chiefly concerned. A chapter is, however, devoted to maize, which was introduced into the eastern Mediterranean by the Venetians and was then widely planted in the Near East by the Turks, to whom its ease of cultivation and rapidity of growth made a great appeal. These cultural characteristics were responsible for its spread in the seventeenth century into south-eastern Europe and, in the western hemisphere, allowed the colonization of North America to proceed much more rapidly than would have been the case had wheat been the staple cereal. In southern Europe, the initial popularity of maize, which soon became the staple food of the poorer classes, declined when its association with pellagra was recognized in the nineteenth century; in the United States, however, the consumption of a mixed diet prevented the appearance of pellagra, and it was not until 1900 that the American taste changed and wheat was preferred to maize flour.

Mr. Jacob suggests that in the early days of human history new inventions would have been quickly forgotten had they not been sanctified by the local religion, but when the barbarian invasions of the Roman Empire brought the Nordic pagan religions into conflict with Christianity, the Roman agrarian techniques were lost in the resulting spiritual confusion, as a result, the Middle Ages became an era of ignorance and famine. Religion itself is shown to owe much to agriculture. Thus the cults of Demeter in Greece in the seventh century B.C. and of the maize god in Mexico in the fifteenth century A.D. were but recognitions of the importance of cereals in the food economy, while, in the Christian religion, with its controversies over the doctrine of transubstantiation, bread acquired a spiritual rather than an economic significance. Once the concept of personal freedom had been developed (a concept absent

from ancient Egypt), the coexistence of a stable political structure and of an impoverished peasant class was impossible, and the expropriation of the peasants is considered by the author as an important causal factor for the decline of the Roman Empire, for the European peasant wars of the Middle Ages and for the French Revolution. The importance of an adequate food supply (of which cereals and potatoes form the basis) in the waging of wars is further emphasized by reference to the American Civil War, the Napoleonic Wars, the War of 1914–18 and the present War.

The author points out that after the discovery of agriculture and the invention of the plough by primitive man, no important scientific agricultural advancements occurred until the seventeenth and nineteenth centuries A.D. The developments of the seventeenth century took place in England and consisted of the invention by Tull of a mechanical plough equipped with a sowing device and the evolution by Viscount Townshend of a four-year crop rotation. In the nineteenth century, developments in the United States were concerned with the technical improvement of agricultural machinery, whereas in Europe the work of Liebig and Pasteur together laid the foundations of agricultural chemistry. During his life-time, Liebig's work was unknown in the United States, and it was not until 1935, when soil erosion assumed immense proportions, that the Americans adequately realized the importance of a biological approach to the problems of soil cultivation. Mr. Jacob emphasizes that the range of climatic conditions within which wheat can be cultivated has been greatly extended by selective wheat breeding and by Lysenko's discovery of vernalization; but his cursory accounts of Mendelian heredity and of vernalization do not accord with the economic significance he rightly attaches to these two processes.

The specific history of milling and bread-making is scattered throughout the book, and is treated in rather a general and cursory way. In the case of reductional roller milling particularly, more detail concerning the various operations could advantageously have been included. The invention of mechanical mills by the Romans, and of windmills in the Middle Ages, and at the end of the eighteenth century the use by Evans in the United States of steam as the source of power for all the milling operations are regarded by the author as landmarks in the history of stone-milling. The principle of reductional grinding was first introduced in 1760 by Malisset, and the superior digestibility of the resulting flour, which unlike that hitherto produced was relatively free from finely divided bran, was soon recognized by Parmentier. It was not, however, until the invention of the roller mill in 1830 that reductional grinding and the consequent production of white flour became universal.

Mr. Jacob points out that bread was first made by the ancient Egyptians and, until the Middle Ages, when the miller became a countryman and the baker a townsman, milling was performed by the bakers. In the Middle Ages, the scarcity of grain resulted in the baking of substitute breads many of which had no nutritional value, while just prior to the French Revolution the use of potato flour in bread-making was investigated by Parmentier. After the Revolution, the consumption of rye bread gradually declined throughout Europe, but no important developments in bread-making occurred until about 1920 when the mass production of bread began. The enrichment of white flour with vitamins and minerals in the United States—surely a landmark in the history of bread—is only discussed very briefly.

Mr. Jacob has presented an interesting historical account of cereal cultivation, and his book should stimulate among general readers an interest in anthropology and history. It is unlikely, however, to arouse much enthusiasm from cereal chemists.

Norah J. Watts.

## REINFORCED CONCRETE STRUCTURES

**Reinforced Concrete Simply Explained**
By Dr. Oscar Faber. Third edition. Pp. 80. (London: Oxford University Press, 1944.) 6s. net.

**Simple Examples of Reinforced Concrete Design**
By Dr. Oscar Faber. Third edition. Pp. 84. (London: Oxford University Press, 1944.) 6s. net.

The fundamental ideas behind the design of reinforced concrete structures are simple and can be stated in a few elementary formulæ. The author of the present volume, which appeared first in 1922, aimed at producing a simple book on the subject which could be understood by comparatively non-technical readers, and the appearance of a third edition at the present time is evidence of the success and usefulness of his effort. The well-known "Code of Practice" for reinforced concrete has been adopted, with modifications, by the L.C.C. since the appearance of the first edition, and the present issue has been brought into line with the existing regulations of that body. The subject-matter covers the treatment of beams, columns and slabs, the shearing resistance of beams, and a discussion of the materials used.

Generally, the presentation fulfils its purpose, but there are occasional places where further revision would be valuable; for example, the statement on page 12, "When steel is stressed in tension it elongates and the amount of the elongation depends directly on the stress, on the length of the bar and on the material (This is called Hooke's Law)". The diagrams, too, vary considerably in style, and the general appearance of the book would be improved if they were made uniform.

These, however, are comparatively small points, and this introduction to a subject on which so much has been written has served, and will continue to serve, a very useful purpose.

The present edition (the third) of the companion volume brings the examples of calculation into line with revised official regulations necessitated by the development of materials and of design technique. The structures dealt with are intentionally simple, but they are well graded. The six examples are a circular water tank, a square tank, a floor slab and beams, a warehouse floor on concrete columns, a retaining wall and a water tower. The calculations are set out in detail, and reasons are given for the various steps and decisions taken. Perhaps one of the most useful features is the insertion of comments on practical constructional details drawn from the author's wide experience; this makes the examples very much more than mere arithmetical exercises.

The book is already well known from the earlier editions, and there is no doubt that the present generation of students and young designers will welcome this revised edition.

## Clowes and Coleman's Quantitative Chemical Analysis

An Intermediate Text-Book. Revised and edited by Dr. Julius Grant. Fifteenth edition. Pp. viii+557. (London: J. and A. Churchill, Ltd., 1944.) 21*s*.

ALTHOUGH this edition is sixty pages shorter than the previous one, published in 1938, the new editor states in the preface that much new material has been incorporated and that deletions are confined to doubtful or redundant material, all the classical methods being retained. The whole text has been carefully revised, and the new parts represent standard modern methods which should be described in such a work.

Clowes and Coleman's book, which was first published in 1891, is, so far as the reviewer knows, unique. It is at the same time a student's manual, providing a carefully graded course, and giving all the detail necessary for the successful procedure of the analysis, and also a very useful reference book to practical analysts. It covers a much wider range of subjects than most books of its size, and includes a number of sections on such subjects as water analysis, foods, oils, fats and waxes, soap, organic analyses, gas analysis, and some physico-chemical determinations such as vapour densities and molecular weights. The reviewer has often followed the book in past editions in carrying out analyses with which he was not very familiar, and in all cases has found the methods described satisfactory and accurate. The book is full of useful practical laboratory hints, and a good index makes it easy to use. There can be little doubt that in its modernized form, in which important and well-tried new methods find a place, the book will continue to maintain its deserved popularity. The paper, printing and binding are all very good, and the way in which it opens easily will be appreciated by workers at the laboratory bench. The book is recommended to students, teachers and practical analysts.

## Cattle at the Crossroads

Broadcast Discussions in the Home Service of the B.B.C. on Cattle Breeding from the Series 'Farming Today'. Pp. 60+8 plates. (Worcester: Littlebury and Co., Ltd., n.d.) 5*s*. net.

A SERIES of six broadcast discussions on the breeding, rearing and management of cattle in Great Britain is here printed, almost verbatim, from the original script. Designed principally for the interest and information of the small farmer, each talk is in the form of a dialogue between an expert in the field discussed and an eminent practical farmer, with the chairman (Mr. W. S. Mansfield) guiding the discussions and linking them together.

The speakers were drawn from widely different areas of the country, and the complexity of the cattle industry in Britain is thus well illustrated. Points touched upon—all very briefly—range from mastitis to the effects of the bull licensing scheme, and from hill cattle to artificial insemination. Problems considered are mainly the immediate ones of dairy farming and that of the post-war source of animals for beef production. The viewpoint is that of the producer: there is little consideration of the effect of government policies, and less of marketing arrangements and consumer-preferences.

The title is apt because the average quality of our milking cattle is poor, and greater efficiency will be required after the War. The discussions show how greatly the prospects of improvement depend upon a proper understanding by breeders—the majority of whom are not specialists, but mixed farmers—of their objectives.

## Man Studies Life: the Story of Biology

By G. N. Ridley. (Thinker's Library, No. 97.) Pp. x+109. (London: Watts and Co., Ltd., 1944.) 2*s*. 6*d*. net.

AMONG specialists it is a common fallacy that, to obtain the interest of the general reader in a new subject, the introduction must consist of a potted version of the whole study under consideration. Usually, after reading one of these potted works, the unfortunate layman has to sit back until he has recovered from the pangs of mental indigestion; and when he surveys this miserable scene, the educationist once more sadly shakes his head and murmurs: "Too much attempted; too little done!" "Man Studies Life" is such a work. The author set out to write a book which badly needed writing—the story of the growth of biological science throughout the ages. In trying to condense that story into a slender volume in which almost every outstanding figure in biology is mentioned, Mr. Ridley has succeeded in producing only a disconnected series of bits and pieces which would be of doubtful value even to the most intelligent layman.

There are few diagrams, one of which is confusing, while another, a time-chart of science, would be extremely valuable if it were more directly related to the text. The whole appearance of the book is too drab to be inviting, a failing which "conformity with the authorized economy standards" does not wholly excuse.

If this book were expanded to four times its present size and presented in a brighter battle-dress, it would be received with avidity by many non-specialist readers. T. H. H.

## Applied Electricity

By A. W. Hirst. Second edition. Pp. xii+367. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1944.) 17*s*. 6*d*. net.

THE demand for this type of text-book has enabled the author to make some useful additions, particularly chapters on power distribution and thermionics. A chapter on materials gives useful notes on a subject which is too often glossed over, although pivotal in industry. In general, the text is adequate for the new Section B in the A.M.I.E.E. examination, and for the Engineering Cadet course. The treatment is everywhere clear and to the point, except in those aspects to which the reviewer objected in the first edition, namely, the relevant torque in a rotary machine is not on the conductors but on the iron, and the confusion between the terms 'electromotive force' and 'potential difference' (p. 70). While one can properly speak of the 'counter-electro-motive-force' in an inductance or condenser (better 'capacitor', according to the latest B.S.I. Glossary), because of the storage and delivery of electrical energy temporarily transformed, one simply cannot accept in these days 'counter-electro-motive-force of a resistance'. When the author states a Kirchoff Law as "the algebraic sum of all the E.M.F.s in any closed circuit is zero", what would he say of a uniform closed conducting ring embracing an alternating magnetic field? There is certainly a single Faraday electromotive force, but there is no potential difference that can be measured anywhere. L. E. C. H.

# ADVENTURES IN PHENOMENOLOGY

By F. I. G. RAWLINS

THE year 1938 marked the end of two lives rich in achievement, those of Edmund Husserl and Samuel Alexander. Not only so, but 1859 witnessed the birth of each of them. So far as Great Britain is concerned, it is scarcely possible to imagine a greater contrast between two contemporaries in regard to influence and knowledge of their works: Alexander, widely recognized and read; Husserl, almost unknown, except to the few. Perhaps it is needless to pursue this matter further, except to remark that Husserl has been but little translated into English, and that in the original German his style, but more particularly his thought, is difficult and complex to a degree rarely encountered even in the *Geistliteratur* of Continental philosophers and psychologists.

All the more, therefore, is it an occasion for deep satisfaction that in gratitude to the great thinker of Freiburg, some of his old students, admirers and critics, who now hold distinguished positions themselves, should have combined to contribute in English a volume of philosophical essays in his memory, under the editorship of Prof. Marvin Farber of the University of Buffalo*. At the end, they have included a fragment by the master himself (in German), dealing with the origin of space. It is a precious little thing, vivid and informal, written in two days during the spring of 1934. We will leave it at that. Our concern is more with those who in this book have laboured, with considerable success, to bring Husserl before the English-speaking world of scholarship. But lest it should be imagined that his genius has meanwhile become sterile, or his flame extinguished, be it remembered that a regular publication entitled *Philosophy and Phenomenological Research* exists, devoted to the furtherance of his doctrines. In the United States, too, the presence of many of his disciples at the head of philosophical faculties is a testimony to Husserl's power as a teacher.

To trace the pattern of his thought, it is well to recollect that the nineteenth century produced a heavy pressure by scientific facts to obtain possession of the domain of 'intrinsic requiredness', a terrain necessarily strongly defended by the philosophers, but—on balance—favourable to attack. Husserl knew this only too well, and initiated counter-measures designed to focus attention upon 'things themselves' rather than upon such doubtful devices as learning and evolution to explain logical principles. This urge to basic contemplation of an object is extraordinarily difficult to implement: it is akin to an art. In any event, it is the activity which for Husserl constituted phenomenology. The word itself, however, appeared in English long before that, seemingly towards the end of the eighteenth century, when it was used in a far more naïve sense by Robison. Moreover, the present context has little in common with the term occasionally found in the theory of models, beloved of nineteenth century physics.

Phenomenological observation is more than straightforward attention; it is essentially reflective. The difference is between description of objects *per se* and that of *intentional* objects. Generally, observation within the natural sciences is 'simpliciter', rather than of the extreme kind demanded by Husserl. It is important to realize this in view of the way in which phenomenology exhibits certain parallels with Aristotelianism, and therefore with the concepts of substantial form and matter as the schoolmen knew them. For us to-day, the fear of introspection may go too far: clearly if the process leads to an arbitrary, even capricious, dichotomy between genuine and spurious reactions, then it is reprehensible. But nobody can seriously discard it in so far as it concentrates our mental powers upon things themselves. At least it formed at one time a fair part of the psychologist's method, even if to-day its findings are considered as a creed outworn.

We have now arrived at the threshold of Husserl's early battles, namely, those with the manifestations of 'psychologism' in its various forms. This arch-enemy, as he conceived it, is a tendency to make reason depend upon something other than itself. Phrases like 'the group mind' or 'the mind of a certain cultural epoch' are suspect from this point of view. Reason is reason *pure et simple*, and to assert otherwise is to forfeit any claim to be on the side of the angels. Years ago, Koffka saw this hazard clearly enough, and with characteristic courage assembled all the forces of the *Gestalt* psychologists to vindicate their integrative principles at the crucial point. And on the whole, not unsuccessfully. In fact, 'once bitten, twice shy'.

Can it, however, be said that, as the history of thought through the ages is unfurled, any well-established philosophical system as such has attained even partial victory over the evils of psychologism? A reply to this question is one of the most remarkable passages in this collection of essays. The perennial philosophy is found to face up to the problem squarely, and starting from Plato's onslaught upon the Sophists, to grapple with it. Recalling the present-day interest in the revival, in modern form, of scholasticism, this inherent capacity of Aristotle, St. Thomas Aquinas and their followers to provide a contingent for Husserl's army is extremely significant. His radicalism, issuing in a fierce striving for a 'presuppositionless' philosophy, is enough to entitle him to a high place among the candid friends of learning, be they of the world or of the cloister. Indeed, the word 'psychophysics' has come into use now, a study partially anticipated by Brentano, when he introduced his conception of intentionality of consciousness. He tries to distinguish between physical and psychical phenomena by ascribing to the latter a species of vectorial property. The details are rejected by Husserl; but the suggestion is intriguing on account of its obvious importance for theories of the numinous on one hand and of the psychological view of causality on the other. It was G. E. Müller who once remarked that contact with psychological problems was a pre-condition for any final acceptance of a system of physics. At this stage it is just as well perhaps that not everybody is irrevocably committed to a completely rigid necessitarianism in human affairs.

The question now is whether the *supposedly* real is *really* real. This is almost, if not quite, the fundamental connexion between phenomenology and epistemology. In other words, what, if anything, does the 'reality-phenomenon' tell us about 'real' reality? A number of criteria can be advanced in favour of the reality-phenomenon, of which the following are examples, not necessarily complete:

* Philosophical Essays in Memory of Edmund Husserl. Edited by Prof. Marvin Farber. (Published for the University of Buffalo.) Pp. viii+332. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1940.) 22*s*. 6*d*. net.

(1) Readiness, (2) persistence, (3) the perceptual periphery, (4) boundaries in concrete objects, (5) independence, (6) resistance, (7) agreement. A conservative view would suggest that there is at least a measure of reality behind the reality-phenomenon; but this is not to assert that complete identity can be expected in the case of sense perception. It may well be that some kind of equivalence is the most that mankind can achieve.

Phenomenology has already been likened to an art. This resemblance receives new force from the concept of 'horizon' which Husserl first evolved in 1913. To explore the horizon implies a move away from 'under one's nose' to a broader context. In *Gestalt* terminology it is a drive for integration; in poetry the psalmist's cry, "I will lift up mine eyes unto the hills, from whence cometh my help". Again, horizon simulates a frame, a hand outstretched towards articulation and a recognition of wholeness. But there is no need for such a frame to be irksome; ever new horizons appear as we shift away from the centre, a type of expanding experience. Teleological metaphysics invoked 'art' to couple together object and human situation: Husserl substituted 'constitution' and, as a result, found himself in an atmosphere of intense radical idealism.

A difficulty, apparently inseparable from much of this activity, arises from the temptation to assume that its penetrating light can be cast upon problems of theoretical physics in their present form. At the moment, this is an error. The contrast is mainly between logical empiricism and phenomenology, with little effect outside what the men of science would commonly call philosophy. Logical empiricism, flowing from the Sophists, continues in its historic course alongside, but separated from, the waters welling up from Plato and Aristotle and finding rest in Descartes and Leibniz. In a way, these latter seem nearer to Husserl. However, the natural sciences to-day are not altogether enamoured of Cartesianism, and a natural question to ask is whether any bridges exist, or whether they have already been blown. Two signs look hopeful (at least as regarded by those who believe it not impossible to retain and even to reinforce the solidarity of knowledge); one is the conviction, almost universally held, that Greek geometry is not *a priori*, and the other is the progress made in recent years in symbolic logic. A full grasp of these disciplines is only possible by liberating problems of origin from that mental habit which confuses mind with nature. Clearly, what is involved is no less than the whole structure of history, a position which some other thinkers have adopted, if not with quite the same ruthlessness as Husserl. It is interesting to notice how his radicalism pervades everything he does; it is with him much more than a mere *façon de parler*. For example, he rejects the classical and more traditional concept of a 'root', in favour of the Empedoclean term. This latter is altogether more primitive. It connotes a rough, shapeless thing, rather than the perfect form of mature growth. This is potency—and teleology—with a vengeance; not the ideal—though that is what is sought—but the possibility of life and development. In this is displayed the true historian, and simultaneously the need for 'intentional history' if phenomenology is to live.

Paradoxically enough, however, Husserl produces an analysis of the origin of mathematical physics—without recourse to actual historical inquiry as we know it—by means of his intentional-historical method; an example of the lengths to which empathetic treatment can go.

So far, phenomenology has appeared mainly in the company of the exact sciences; this, however, is far from the limit of its powers. We are faced with what it has to say about the social sciences, art, and in general, the immediate activities of mankind. Later on, however, it will be needful to return to mathematical symbolism, seeking therein the bond between Husserl's earliest work and our hopes for the future. Meanwhile, he strives to appreciate to the full the problem of the *alter ego*. His way of thinking can best be illustrated by a remarkable passage in which he 'dares' phenomenology to enter the dark corners of other people's experience and not to run away, adding that fear of the dark is only for children in philosophy, expecting at any moment to meet the bogey of solipsism. One cannot resist putting this side by side with the Pauline care for those of (spiritually) tender age, offering them milk rather than meat. Thus, as in Corinth long ago, so in Freiburg, the master will demand no more of his followers than he thinks they can bear. Even Leonardo da Vinci confesses to terror of a dark cave when searching for prehistoric bones, but overcoming his emotion, continues his quest and achieves his object. In the abstract, Husserl did much the same in his groping after a phenomenological basis for the social sciences. Above all, he is not prepared to immunize the physical world against mankind.

A natural step from here is into the realm of art. A measure of æsthetic purity involves appropriateness in that there must be purposeful accuracy for the expression of feeling: greatness in a work of art, however, demands profundity in making manifest the depths of being previously experienced. Some years ago Birkhoff evolved his æsthetic formula and by its means gained considerable success in objective judgment relating to patterns, vases, music and poetry. His method was restricted almost entirely to the formal domain of art. Later, the present writer attempted an application of *Gestalt* principles to paintings, based essentially upon energetics. This treatment tried to penetrate the fringe of the connotative region. Phenomenology shows a certain divine discontent with the ontological in its more naïve forms, very roughly analogous to the tendency of æsthetic experience to turn inwards upon itself. Nevertheless, though art may be more imaginative than truly inventive, there is an undisputed place for what Samuel Alexander has so well called 'constructive excitement'. Rilke's "Sonnets to Orpheus" contains the words "He binds with more cunning the boughs of the willows to whom the roots of the willows are known". This applies not only to the poet and to the philosopher but also to the man of science. In the early stages of knowledge trial and error may be the only way of making progress; later, a comprehensive grasp of 'requiredness' may enable the whole to be rapidly completed. One gains the impression that Husserl himself no less than those who write in support, or in criticism, of his doctrines are resolved to avoid the cruel folly of conducting a blind man into a pitch-dark room, to look for a black cat that isn't there.

For something like a couple of centuries physicists have worked away without any apparent regard whatsoever for metaphysics. Philosophers, for their part, have not failed to notice the impressive strength of scientific fact arrayed against their own interna conflicts of opinion and so forth. But they are con-

tinually re-examining some of their systems and stressing the need for yet another consideration of the relations between science and philosophy. Phenomenology has not escaped, but has been provisionally eased out a little on a frame of neo-positivism. But the source of inspiration is still Husserl himself. Even his omissions and denials possess importance. For example, for him experience is immediately social in a limited sense, but to say "that one's own experience contains the actual experience of others as real, immanent elements" would be inacceptable by him.

Already in this review a mild defence of introspective methods in experimental psychology has been offered. In virtue of certain materialistic approaches to phenomenology which have been made, it is unavoidable that they must become attractive targets. But their very weakness was one reason among several which impelled the then youthful Wertheimer to heroic efforts to end or to mend psychology as it then was. The result was the founding of the *Gestalt* concept. Ironical as it may be, perhaps intentional-history is asserting itself within the sphere of embryonic research.

That phenomenology is an art, a methodology and even a way of life all at once, should not blind us to its main characteristic as a mental construct suitable for dealing with the Universal rather than with the Particular. It is therefore not surprising that some of Husserl's followers should be attempting something like a metaphysics of the factual element. One such system is sketched in the work now before us. It is distinguished for its moderation and resilience. At least, it is held, mankind can express a desire to understand the world without postulating that it is wholly 'intelligible'. It will suffice for the purpose if the world is 'fact', but not 'mere fact'. The significant point is contained in the attitude that slavery to fact may be quite as oppressive as that to 'authority' and the rationalizers. The latter types of bondage produced a series of explosions too well known to need recapitulation here. But a decision in advance never to venture outside 'mere fact' (if only, so to say, for fun, to see what happens) is as dyspeptic as it is unenterprising. Metaphysics is not prepared to come to terms finally either with 'authority' or with 'mere fact', if only because, should the world be meaningless, so would metaphysics be too. Doubtless there will be some dissent from much of this, but it is refreshingly robust all the same. One should not read these essays in and around Husserl's life and influence unless reasonably shock-proof. Their charm —which applies to one and all—resides very largely in an engaging humility and a certain lack of the doctrinaire, ready to 'take it all back' if something better can be found.

A contribution entitled "Men and the Law" is included in the collection. At first glance it would seem to have little to do with phenomenology. But it is followed by another, the theme of which is symbolic logic. The juxtaposition of these two articles was a happy thought, for between them they supply something very valuable indeed. Briefly, it amounts to this. The law says *yes* or *no*. It is not directly concerned with the vast majority of the events of daily life, which fall well within the excluded middle. Its power is of another kind. Now mathematicians are intent upon the quest of finding a place for *possibility* in symbolic logic, as 'objectivized' by Hilbert's quantifier ($\exists x$). Is it at least conceivable that, far ahead, some light will come from this quarter to illuminate the very practical twilight subjects like rheology and, more generally, the applied sciences? A philosophy of the latter is awaited with some impatience for regions in which academic simplifications do not, and cannot, hold, and wherein 'facing the facts' is almost literally all that can be done.

So now, Prof. Marvin Farber and his colleagues bring their tribute volume to an end. Poured forth in honour of a master mind, their libations leave a most gracious and lasting impress, as they trickle silently away.

# ESTABLISHMENT OF VEGETATION ON COAL TIPS AND OTHER SPOIL MOUNDS

By J. W. B. SISAM
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AND
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SPOIL mounds of varying type and composition are the inevitable end-product of many mining and manufacturing operations. Anyone familiar with the Black Country of England or the mining areas of South Wales, to cite two important examples, well knows how the countryside can be disfigured by these tips. Under natural conditions considerable time may elapse before even a coarse grass or scrub vegetation becomes established on such material, and then the result is of little æsthetic or economic value. While in the past a certain amount of work has been undertaken locally in reclaiming tips of various kinds, usually through afforestation, such programmes have been limited in scope and difficult to maintain. It is only recently that there has been any widespread interest regarding the vegetation of spoil mounds by artificial means, with or without preliminary levelling, in order to improve the landscape, amenities and living conditions in the districts concerned. It is the purpose of this short article to indicate how knowledge on the ecology of pioneer vegetation, both forest and grassland, can be applied to this particular problem, and to suggest methods of establishing a vegetation cover on what may appear to be a not particularly promising medium.

In Great Britain, the industries responsible for spoil mounds include coal-mining, quarrying for iron and other minerals, and the manufacture of chemicals, pottery and glass. The vegetation of the tips and general waste material from these industries has been referred to in the reports of the Scott and Kennet Committees, and is receiving the attention of several Ministries, of local planning organizations such as the West Midland Group on Post-War Reconstruction and Planning, of local authorities such as borough councils in South Wales, and of the industries themselves. The problem is also being studied in the United States, South Africa and Germany.

When once the planning authority has decided on the general purpose of the reclamation, whether for amenity purposes (landscape improvement and provision of parks and recreation grounds) or for yielding an economic return, it becomes the task of the plant ecologist and the soil specialist to decide which species

of trees, shrubs, herbage or other plants are adapted to this rather abnormal environment, and what method of establishment would be most efficient for the purpose in view. Surveys are necessary to determine the degree of weathering of spoil material, the nutrient or toxic status of the forming soil, the soil moisture and degree of drainage within tips, the surface temperature and the degree of erosion and soil-wash. The problem of air impurities in districts still in active production must also be considered.

It is probably correct to say that the establishment of grass swards should be attempted only when levelling can be done. If the cost of such an operation with modern mechanical equipment is not prohibitive, and land adjacent to the tip is available, the ultimate creation of pastures or parkland can be visualized. The establishment of grass can be greatly accelerated if a covering of six to nine inches of soil or a compost made from town waste can be provided, but it should be possible to establish certain types of grass even on the crude tip material after a certain amount of weathering has taken place, especially if the weathered surface layer on the tops of the mounds is carefully preserved during levelling.

If soil is available, the usual technique of establishing grass on poor soils can be adopted, starting possibly with rape and turnips that can be grazed with sheep, and following with a grass-legume seeds mixture composed according to local conditions and requirements. Direct turfing is also possible, particularly in the formation of bowling greens.

If soil is not available, it will probably be necessary to use species with very low fertility requirements, not generally used for agricultural purposes. Surveys of natural revegetation made by botany students will provide useful information for this work. There are indications that grasses requiring low fertility such as *Aira cœspitosa*, certain species of *Agrostis*, and certain weeds could be established, and it may become necessary to commence the production of seed of unusual plants for this purpose. Lupins are important legumes that can be grown for increasing the nitrogen content of the soil. The non-palatable species are generally used, but it is desirable to test the sweet varieties, as these could be grazed at the appropriate time, and the soil would thus gain considerably from the sheep droppings. Unorthodox methods such as the spreading of mixtures of root or rhizome cuttings of bracken or *Agrostis* may be applicable in certain circumstances. The ultimate aim of all this work must be to improve the organic matter content and nutrient status of the soil as rapidly as possible, up to a stage when the establishment of secondary and superior species with higher fertility requirements can be attempted.

The creation of market gardens and allotments on tip soil is dependent upon the availability of organic manures. If stable manure or similar material can be obtained, good crops of vegetables can be expected, and have actually been obtained on the tops of coal tips.

In many cases, however, tree planting will be the method adopted for spoil-mound reclamation; the cost of levelling may be prohibitive, or the general landscape plan may require the establishment of plantations for timber production or the planting of individual trees in parkland development on levelled or partly levelled tips. Here the general principles of the ecology of pioneer vegetation will again apply, although this aspect of the subject raises a number of special problems.

The choice of tree species, the size and quality of the planting stock, and the method of planting to be used can be decided only after a careful study of the site. Waste materials are extremely variable in composition and rate of weathering, and species that do well on one site may not do so on apparently similar sites; each case must be dealt with on its own merits. Mention has already been made of the site factors that require to be surveyed; where possible a chemical analysis should be made of the constituent material of the tip before any reclamation work is undertaken.

Old, well-weathered spoil mounds, particularly those consisting of easily decomposed materials such as certain shales and fire clay that has been burnt, are readily covered with natural vegetation and should offer little difficulty in the establishment of trees. On the poorer sites, where the material is largely unweathered and sterile, it is of the greatest importance to improve the humus content and moisture-retaining capacity of the soil as rapidly as possible. The first trees to be planted on these sites should have the characteristics of true pioneer species—low nutrient requirements, a vigorous and penetrating root-growth, and the ability to build up the organic content of the surface soil through the annual fall of leaves and other debris. Species of willow, birch, poplar and alder are useful for this purpose.

Best results may be obtained if the trees are planted with their roots in a ball of earth, and such treatment is essential if species with more exacting site requirements are used. In general, it is recommended that the planting stock be 1-year transplants not more than 2 ft. in height, although poplars may be up to 5 ft. high; the plants used should have a well-developed fibrous root system and should be planted to the same depth as when taken from the nursery. They should be spaced at about 5-ft. intervals and left to form canopy before thinning. Poplars have been successfully established on a fairly well weathered tip of shale and clay by placing cuttings in holes 12 in. deep, made with a crowbar, and consolidating colliery slag around the cuttings. The only subsequent treatment was the application of manure to the base of the saplings at the end of the first year.

If feasible, a new tip may usefully be covered with a layer of soil, and the use of 'over burden' from sand quarries has been suggested for this purpose. The danger of drought in the summer, due to lack of contact with sub-soil moisture, can be counteracted by placing some peat in the planting hole. Alternatively, if the tip has weathered for some time and bears a skin of coarse grass over unweathered material, the turf removed for purposes of tree-planting should be inverted, placed in the planting hole and covered with fresh soil. Moisture conditions will be improved as the turf gradually rots and forms a humus layer. In addition, the sowing of common lupin seed in the inverted turf some time before the trees are planted will help to increase the available nitrogen in the soil. Gorse, broom and alder are also valuable as nitrogen fixers, and, in addition, provide shelter on bare, exposed sites if established before the young plants of the main crop are put in. As site conditions improve, species of greater economic value, having higher fertility requirements, may be used. Among the tree species that have been recommended for use on spoil mounds in Great Britain, in addition to those already noted, are mountain ash, elder, wild cherry, wych elm, hawthorn, laburnum, sycamore, ash, Austrian pine, Corsican pine, Scots

pine and European larch. Of the conifers, Corsican pine is particularly recommended, as it is not exacting in its requirements, stands up to smoky conditions, and thrives on a low rainfall.

Apart from soil conditions, the choice of tree species may be limited owing to exposure of the site to wind and insolation, especially at high elevations. In exposed situations, where shelter is required at any cost, alder, wych elm, thorn, elder, willow and stout birch plants have been recommended. The conifers, Sitka spruce and Scots pine, are suited to planting at relatively high altitudes. On exposed sites it is important that the planting stock be not too large in order to avoid damage by wind before it becomes properly acclimatized.

Air pollution by certain gases may prevent the establishment of any kind of vegetation, while with other forms of pollution, such as smoke, vegetation can be grown, but the species must be carefully selected. Deciduous species have an advantage over conifers in that they lose their foliage annually, whereas conifers usually retain their needles for several years. Among the species that have been recommended to stand up to smoky conditions are alder, willow, birch, mountain ash, London plane, certain species of poplar and Corsican pine.

A hazard to the success of spoil mound plantations that has nothing to do with choice of species or method of planting is the possible interference with, and injury and ultimate destruction of, the trees by animals or human beings. Fencing affords protection, but is expensive and not necessarily effective where children are concerned. It is far better to give them a personal constructive interest in the plantation by enlisting their help in its establishment.

The ultimate value of tree plantations depends not only on the successful establishment of the plants but also on their subsequent care, particularly in the early stages of development. Close attention should also be given to the sequence of succession that will best meet the needs of the planning authorities and at the same time satisfy ecological requirements.

With reference to the problem of spoil-mound reclamation in Great Britain, the general conclusion that can be drawn after visiting representative areas in the Birmingham conurbation and in South Wales is that a great deal can be done in a short period, and reasonably soon after tipping has stopped, provided soil analyses are made and expert advice taken regarding the selection of species and the methods that are to be adopted. A full statement of the information available from the literature and from local experience is now in preparation, to be issued as a Joint Publication of the Imperial Agricultural Bureaux.

# OBITUARIES

## Sir Julien Cahn, Bart.

SIR JULIEN CAHN, BART., who died on September 26, aged sixty-two, was known to a wide circle as a keen sportsman; he was particularly interested in cricket and he took teams to many parts of the Empire and to many countries. He was a far-seeing philanthropist, being a generous supporter of medicine and hospitals and particularly of the cause of reducing maternal mortality. It was due, too, to Sir Julien Cahn's munificence that it was possible to found the Cahn Hill Improvement Scheme in connexion with the University of Wales, Aberystwyth—that was in 1932 and before any purposeful action was being taken to increase home food production in the event of war. The nation owes much to Sir Julien Cahn because, as a result of the experiments then started on the hill and rough lands of Wales, the foundations were laid for establishing a technique applicable to the radical improvement and more intensive utilization not only of such lands but also of much neglected pasture in the lowlands.

During the War of 1914–18, the rough and hill lands of England and Wales (more than 5,000,000 acres) made no materially increased contribution to our food resources: in this War the matter has been very different, as is well exemplified by the pioneer endeavours of the Montgomeryshire War Agricultural Committee and by the work undertaken by the Committees in Lancashire and Breconshire and by those of many other counties of England and Wales. The success and magnitude of all this work have been, in no small measure, due to the good and quick start that was rendered possible by the results of the investigations which Sir Julien Cahn had so largely financed. Of the many lessons of the War, few are more compelling than the emphasis that must necessarily be put on the importance of the rising generation and on a thriving agriculture, capable at all times of producing an abundance of food.

The War has, therefore, greatly accentuated the wisdom behind, and the value to the nation of, Sir Julien Cahn's benefactions—benefactions which have served as an inspiration to large numbers of workers in two of the most important fields of national endeavour.

R. G. STAPLEDON.

## Prof. F. Plzák

NEWS has reached London that the death of Dr. F. Plzák, professor of organic chemistry at the Charles University of Prague, occurred there on May 4. Prof. Plzák, who was sixty-six years of age, had occupied the chair of organic chemistry since 1910 and was at one time well known in America and to a less extent in Great Britain, being a frequent visitor prior to the outbreak of the War of 1914–18. Before entering the University he was employed in a pharmacy and did not graduate until he was twenty-five years old. Then he went to Zurich to study under Prof. Lorenz before becoming, first lecturer and then (1910) professor of organic chemistry. His researches were not numerous and mainly related to the lesser known alkaloids (for example, tubocurare) and glycosides (for example, cyclamin, $C_{63}H_{110}O_{32}$, which he found in potatoes as well as in cyclamen tubers, and showed to contain various sugar groups). Plzák was part-author (with Prof. Baborovský) of a standard Czech work on electrochemistry.

As a part of the Czech University, his laboratory was closed by the Germans in 1939 and Plzák, like the other professors, was relieved of his post. Afterwards the Chemical Institute was reopened with a German staff.

WE regret to announce the following deaths:

Dr. E. L. G. Clegg, director of the Geological Survey of India, on September 8.

The Right Hon. Sir William Mulock, K.C.M.G., vice-chancellor (1881–1900) and chancellor since 1924 of the University of Toronto, on October 1, aged one hundred.

# NEWS and VIEWS

## University of Ankara

THE University of Ankara has appointed the following, nominated by the British Council, to professorships: Mr. B. E. C. Davis, reader in English language and literature, Westfield College, University of London, to the chair of English; Dr. W. J. McCallien, Carnegie teaching fellow in geology in the University of Glasgow, to the chair of geology; and Prof. J. A. Strang, professor of mathematics in the University of Lucknow, to the chair of mathematics.

British scholars already occupy ten chairs at the University of Istanbul, as follows: Prof. C. E. Bazell (English philology); Prof. F. H. Constable (physical chemistry); Prof. P. du Val (mathematics); Prof. V. H. Legg (industrial chemistry); Prof. A. K. McIlwraith (English); Prof. W. C. W. Nixon (gynæcology); Prof. J. S. Rankin (theoretical mechanics); Prof. F. Royds (astronomy); Prof. the Hon. Stephen Runciman (Byzantine art); Prof. Ronald Syme (ancient history).

## British Trade Associations: Structure and Functions

THE broadsheet "British Trade Associations" which has been issued by P E P gives a description of the structure and activities of these associations, which should provide a useful factual basis for discussion of a subject much to the fore at the present time. The arguments for and against trade associations and related questions of policy are not considered, but this well-documented summary of the internal structure, functions and techniques of trade associations and of recent trends, such as the growth in numbers, in the representation both of firms and of output in a given trade, the range of activities, the growth of distributive and composite associations, and the coalescence of trade associations, should at least stimulate the growth of informed opinion of this subject and facilitate its objective discussion. In regard to technical functions, trade associations have furthered co-operation in such matters as standardization, pooling and interchange of patents, and research. Discussion and negotiations with Government departments and co-operative advertising are also considerable spheres of activity. Commercial functions may be distinguished as non-regulative, such as credit bureaux, mutual insurance schemes, market research, and, less frequently, joint purchase of materials and regulative activities. The latter are of four types: control of prices, as by price agreements; control of the channels of distribution; the regulation of productive activity; and the centralization of selling activities. Examples illustrating all these activities are cited in the broadsheet, which also points out that in practice it is not always easy to maintain the distinction between trade associations concerned primarily with trade, and employers' federations which are concerned primarily with labour questions.

## Royal College of Physicians of Edinburgh

ALTHOUGH research work is the major occupation of the staff of the Laboratory of the Royal College of Physicians of Edinburgh, the Laboratory has, during the War, been occupied with Government work for the Armed Forces and for the Emergency Medical Services. In the annual report for 1943 of the Curator, it is stated that the agreement between the College and the Carnegie Trustees for the Universities of Scotland, made forty years ago, is being modified as from this autumn. The Trustees will retain the proprietor's obligations in respect of the building in which the Laboratory is situated and will contribute £1,000 a year for research for five years, but the treasurer of the Carnegie Trust will no longer do the Laboratory's accounting work. The retirement of Mr. James Davidson, who for forty years has acted as the Laboratory's treasurer and financial adviser, ends a long and devoted service. Plans for reorganization and future work depend on the development of post-war medical schemes in general.

Considerable work has been done by the Laboratory on the histology of cancer, on sarcoma of the breast and on tumours of the adrenal gland, the nervous system and the pituitary gland. Other problems studied have been congenital microphthalmos in mice, a research promoted by the Ross Foundation for the Study of Blindness, Edinburgh; the diagnosis of sterility; and the study of hæmoglobin and the testing of hæmoglobinometers. The Biochemistry Department, directed by Dr. W. O. Kermack, who also directs the Department of Statistics, has continued the difficult study of the synthesis of new anti-malarial drugs, and considerable progress has been made. The Bacteriological Department has studied the anaphylactic theory of rheumatic diseases and is engaged on the typing of pneumococci and on chemotherapeutical research on corneal infections, which has shown that the cornea of the rabbit is highly susceptible to the gonococcus and can be used for chematherapeutic research on this organism. Work on blood groups is planned for the future. During 1943 the Laboratory issued 22,461 reports on laboratory findings, and this side of its work is increasing. This work provided a revenue of £5,744, with a profit of £781; it is thus a valuable help to the finance of a laboratory which is not run for profit, but seeks only to maintain itself and to contribute to the advancement of knowledge.

## Paper for School Text-books

IN reply to a question in the House of Commons on October 12 referring to the shortage of school text-books, Mr. Butler, Minister of Education, said: "I have been in touch for some time with those of my colleagues who are concerned with the object of securing an increase in the allocation of paper for educational books, and I am glad to say that, in spite of the many pressing calls upon the available supplies, a substantial additional tonnage of paper has now been allocated which should go a considerable way towards meeting the most urgent cases of shortage."

## The Reversible Transit Circle, Greenwich

Sir Harold Spencer Jones and R. T. Cullen (*Mon. Not. Roy. Astro. Soc.*, **104**, 3; 1944) describe the principal features of, and preliminary results of tests and observations with, the new reversible transit circle of the Royal Observatory, Greenwich. The instrument was installed in 1936 and replaced the transit circle designed by Airy and installed in 1851. This latter instrument had a wonderful record for work, and the value of the Greenwich meridian observations is due very largely to the continuity of observation with the Airy transit circle. The new instrument was constructed by Messrs. Cooke, Troughton and Simms, Ltd., and follows closely in design the reversible transit circle of the Cape Observatory, designed by Gill. After the erection of

the instrument in February and March 1936, various kinds of researches were initiated, concurrently with observations for the establishment of a fundamental system of right ascensions. The work was interrupted in the autumn of 1940 owing to air attacks on London, and the objectives of the instrument and the two collimators and the micrometer eye-end were dismounted and removed to a place of safety. Fortunately sufficient material had been obtained and conclusions formed to guide the planning of post-war observations with the instrument.

The investigations have shown various ways in which systematic discordances of instrumental origin can enter into meridian observations, and the results may be useful to others who are planning a similar equipment. The paper gives the results of the investigation of the diurnal and seasonal changes of the instrumental errors of adjustment, and it is pointed out that a close control over the error of collimation will be essential when the instrument is brought into use again. A pronounced effect of wind directions on azimuth error has been shown to exist, the correction being a maximum, 0·33″, when the direction of the wind is north.

## Spot Gluing by High-Frequency Heating

ONE of the advantages of high-frequency heating as applied to dielectrics is that it is very easily localized by the use of two small electrodes placed close together. Heating is confined to the material in the relatively strong electric field in the immediate neighbourhood of the gap between the electrodes. A pair of electrodes mounted in a suitable handle and connected by a flexible coaxial cable is sometimes used rather like a soldering iron for the gluing of joints in wood structures. Synthetic resin glues can be heated to the setting point in a few seconds. Another arrangement of electrodes in the form of two small wheels which roll over the opposite faces of sheets of material passing between them has been used as an 'electric sewing machine' for cementing together sheets of material.

Yet another device of this kind is a 'spot gluing' outfit recently developed by Pye Telecommunications, Ltd., in co-operation with Aero Research, Ltd. The electrodes are mounted in the form of a gun, the active electric field occupying the space between the end of the gun barrel and a central electrode coaxial with it. The central electrode is spring-mounted and projects slightly beyond the barrel, and pressure of the electrode on the work is made to operate switches, so that the power is automatically applied for an appropriate time interval, say, 2 sec. In operation, therefore, the process is closely analogous to spot welding, although it is used for tacking components into position when building up a complicated assembly, rather than for making complete joints. The importance of the process lies mainly in the fact that it holds out the possibility of dispensing with the use of brads, metal staples, clamps, etc., in forming some of the complex structures required in aircraft work.

## Crop Rotation

AN entirely new and re-written edition of Bulletin No. 85, "Rotations", has been published by the Ministry of Agriculture and Fisheries (H.M. Stationery Office, *4d.*). The author is Dr. H. G. Sanders of the School of Agriculture, Cambridge, as Prof. R. G. Whyte, writer of the previous editions, was unable to undertake the necessary revision. The principles of rotations are set out clearly, and the Norfolk four-course rotation, which had been followed for some two hundred years on the lighter soils of England, is discussed in some detail. During the last thirty years, however, this system has had to be radically altered to meet changed economic conditions, and cash crops of high value, such as sugar beet and potatoes, have been introduced. The extension of the rotation by means of the seeds ley is discussed, and a separate section is devoted to the special problems on heavy land, while catch-cropping forms the subject of the final section of the bulletin. Emphasis is laid on the fact that for successful farming a thorough understanding of traditional methods is the only sound basis for deviation from established practice.

## Chemotherapy and Tropical Medicine

IN a lecture to the Chemical Society (*J. Chem. Soc.*, 351; 1943), Dr. A. J. Ewins dealt with the above subject, and his lecture is particularly interesting in giving a concise historical account of the development of the use of chemical agents in the treatment of tropical diseases, which are caused not only by bacteria but also by virus, protozoal and parasitic infections. One of the first applications was in the treatment of sleeping sickness, in which the work of Ehrlich was predominant; for many years this field of investigation was one of the major concerns of the great German firms dealing with synthetic drugs, and these may be regarded as having taken a most prominent role in the welfare of parts of the world which otherwise looked to Great Britain as the proper source of research into matters so intimately affecting the Empire. Dr. Ewins is able to show, however, that a start has been made in overtaking the great gap between the development of research in chemotherapy in Britain and our responsibilities to the British Empire, and that the potentialities of such research are now being realized. The lecture is very concise and readable, and is recommended to the attention of all who may be concerned with Empire matters.

## U.S. National Vitamin Association

THE organization in the United States of a National Vitamin Foundation was approved at a meeting of fifty representatives of all sections of the vitamin industry in New York on May 23 (*J. Amer. Med. Assoc.*, July 28). Its objects are to award grants for research in the vitamins or related fields, the dissemination of information in the vitamin trade, medical profession and public with respect to the quality, purposes and uses of vitamins, and to confer and consult with medical societies, medical schools, health organizations, public health agencies and government agencies with respect to vitamins and the vitamin industry. The Foundation will be administered by a board of trustees. Details of the organization are to be formulated by a committee of which Basil O'Connor, New York, president of the National Foundation for Infantile Paralysis, has been made chairman.

## Recent Earthquakes

THE United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has determined the epicentres of three recent earthquakes. The first was on June 28 at 7h. 58·9m. G.M.T. with an epicentre at latitude 14·6° N., longitude 92·6° W., off southern

Mexico. This shock was registered at fifteen American stations and at Honolulu, Ottawa and Toledo (Spain), but not in any strength at Wellington, New Zealand. The second shock was on July 12 at 19h. 30·4m. G.M.T. from an epicentre at latitude 44·7° N., longitude 114·4° W. in Idaho. This was recorded at six United States seismograph stations. The third shock was on July 19 at 10h. 20·9m. G.M.T. from an epicentre at latitude 33° N., longitude 138° E. (off Japan). This was recorded at five U.S. stations and at Honolulu. All interpretations and calculations are tentative. During June twenty-two local earthquakes were felt in New Zealand. One, on June 28, may have attained an instrumental magnitude of 5½. This was felt in eastern and southern parts of North Island and at Nelson just after 13h. 14m. G.M.T. The shock of June 26 had instrumental magnitude 5 and was felt at Gisborne, Hawkes Bay and Taupo region. Several shocks had Scale 4 intensity.

## New Division of the Institution of Civil Engineers

THE Council of the Institution of Civil Engineers has approved the formation of a fifth division to be known as the Works Construction Division, under the chairmanship of Lieut.-Colonel C. M. Norris. Its objects are: "The promotion of the science and art of engineering in relation to the ways and means of carrying out engineering construction on the site: e.g. the use of machinery and plant, the design and maintenance of temporary works, the organization of engineering labour (including foremen and inspectors), and the use and inspection of materials". The opening meeting will be on January 2, 1945, when there will be a discussion on a report on "The Organization of Civil Engineering Work", recently prepared by the Institution and to be available shortly. All corporate members of the Institution who wish to apply for registration as members of the Division should inform the Secretary by postcard, giving name (in block letters), address, and grade in the Institution. The fourth division, approved also during 1944, was the Maritime Engineering Division dealing with harbours and docks, together with works of coastal protection and the like, under the chairmanship of Mr. Asa Binns. This will hold its first meeting on February 13, 1945. The other three divisions of the Institution are those of Road Engineering, Railway Engineering and Structural and Building Engineering.

## Research Grants by the Society of Sigma Xi

ELEVEN grants-in-aid, totalling 2,415 dollars, have been made by the Society of the Sigma Xi, the national honorary research society of the United States. The committee which made the awards consisted of Dr. Harlow Shapley of Harvard College Observatory (president of the Society of the Sigma Xi), Dr. Hugh S. Taylor of Princeton University, and Dr. L. C. Dunn of Columbia University. They are as follow: Robert O. Bloomer, Corcoran School of Geology, University of Virginia, 200 dollars for aid in the study of Pre-Cambrian rocks of the Beartooth Mountain, Montana; Miles P. Givens, Pennsylvania State College, 100 dollars for aid in the investigation of the quantum nature of X-rays; C. Clayton Hoff, Department of Biology, Quincy College, 200 dollars for assistance in bibliographical work and to defray part of the expense connected with the study of the pseudoscorpions (taxonomy and distribution); Frank M. Hull, Department of Biology, University of Mississippi, 150 dollars for the continuation of the study on *Baccha* and *Mesogramma* and related genera of Syrphid flies. Yingchen Li, Department of Forestry, National Szechwan University, China, 500 dollars for the study of seed-production of several varieties of *Aleurites fordii*, the Chinese tung oil tree; David C. McClelland, Department of Psychology, Wesleyan University, 100 dollars for assistance in the preparation of a new scoring key for the Bernreuter personality inventory and for the Strong vocational interest test; Marie B. Morrow, Department of Botany and Bacteriology, University of Texas, 240 dollars for aid in the continuation of studies on methods of preparation of allergenic mould extracts; Donald M. Pace, Department of Physiology, University of Nebraska, 250 dollars for technical assistance in the continuation of studies on growth phenomena in *Chilomonas*; Hugh M. Raup, Department of Plant Ecology, Harvard University, 400 dollars for use in defraying expenses in connexion with the continuation of studies on the botany and plant geography of regions along the new Alaska Military Highway; Sidney Roberts, Department of Physiology, University of Minnesota Medical School, 150 dollars for aid in the study of the source and control of gluconeogenesis in the kidney; Pierre Van Rysselberghe, Department of Chemistry, University of Oregon, 125 dollars for aid in the study of the conductivity of non-aqueous solutions of metallic salts.

## Announcements

THE Paris correspondent of *The Times* states that Prince Louis de Broglie, Prof. Pasteur Vallery Radot and M. André Siegfried have been elected members of the Paris Academy of Sciences, and M. Georges Duhamel has been appointed *secretaire perpetuel*.

THE Lord President of the Council has appointed Sir Frank Smith to be chairman of the Road Research Board of the Department of Scientific and Industrial Research, in succession to the late Sir Clement Hindley.

THE Council of the University of Sheffield has made the following appointments: Dr. Z. P. Dienes to be temporary assistant lecturer in mathematics; Dr. I. F. S. Mackay to be lecturer in experimental physiology; and Mr. H. Lewis, Mr. J. Sedgwick, Mr. S. Waterworth and Mr. D. White to be part-time teachers in engineering.

AT the annual general meeting of the London Mathematical Society on November 16, in the rooms of the Royal Astronomical Society at 3.0 p.m., Prof. Jacques Hadamard, of the Paris Academy of Sciences, will give a lecture, "Psychological and Personal Recollections of a Mathematician". Members of other scientific societies will be welcome.

PROF. S. K. MITRA, of the University College of Science, Calcutta, and chairman of the Radio Committee of the Board of Scientific and Industrial Research of India, who is one of the delegation of Indian men of science now visiting Great Britain, will give a lecture on "Active Nitrogen" at a meeting of the Physical Society to be held at the Cavendish Laboratory, Cambridge, on October 24 at 2.30 p.m.

THE one hundred and fiftieth course of six lectures "adapted to a Juvenile Auditory", the well-known Christmas Lectures given at the Royal Institution, will be delivered by Sir Harold Spencer Jones, Astronomer-Royal, on December 28, 30, January 2, 4, 6 and 9 at 2.30 p.m.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Persistence of D.D.T. in Oil-bound Water-Paint

THE property of D.D.T. of becoming firmly adsorbed on to a surface was demonstrated in the early work of Wiesmann[1], when he found that it was possible to render walls effective against stable-flies and house-flies for periods of about two months by spraying a suspension of a powder impregnated with 5 per cent of D.D.T. Another interesting application of this property is to be found in the fact that garments impregnated with a solution of D.D.T. withstood 6–8 weeks wearing and six to eight launderings before losing their insecticidal efficacy[2]. It has been reported[3] that beds sprayed with a kerosene solution containing 10 per cent of D.D.T. and 5 per cent of cyclohexanone retained the power of killing bedbugs for 104 days after treatment.

The outstanding persistence effect of D.D.T. raises the question as to whether it might be incorporated in paint or other surface coatings, and during the past year we have been investigating this application with promising results[4].

It is natural to expect that if the D.D.T. powder is but lightly bound to the surface, as say, in whitewash or dry distemper, there is every prospect of retaining the insecticidal action; but on the other hand, in the more durable coatings such as oil paints and synthetic varnish paints, one might expect the D.D.T. particles to be prevented from exercising their insecticidal effect because of the strongly adsorbed oil film. These expectations were, in fact, confirmed by our results; but we were particularly pleased to find that when D.D.T. is incorporated in an oil-bound water-paint it continues to exert its insecticidal action.

In the laboratory experiments, plywood was cut to fit inside zinc mesh fly cages. The first cage had plywood—painted with D.D.T. (5 per cent) paint—covering the floor, half-way up the sides and two thirds of the lid, whereas the second cage was covered with an identical area of plywood painted with the same paint in which D.D.T. had not been incorporated. One hundred housefly pupæ in a crystallizing dish were placed in each cage together with containers of sugar and water, and the cages were inspected daily.

The results of one typical experiment are summarized below:

| Date | Cage fitted with wood painted with oil-bound water-paint and D.D.T. | | Cage fitted with wood painted with oil-bound water paint as control | |
|---|---|---|---|---|
| | Flies alive | Flies dead | Flies alive | Flies dead |
| 22/3/44 | 6 | 1 on its back waving its legs | 4 | Nil |
| 23/3/44 | 4 | 3 | 20 | Nil |
| 24/3/44 | 5 | 6 | 35 | Nil |
| 25/3/44 | 6 | 10 | 35 | Nil |
| 27/3/44 | 1 | 15 | 86 | Nil |
| 28/3/44 | Nil | 68 | 86 | Nil |
| 29/3/44 | Nil | 90 | 86 | Nil |
| 30/3/44 | Nil | 93 | 86 | Nil |

From these results it will be seen that the oil-bound water-paint incorporated with D.D.T. was effective against houseflies, and tests carried out after two months showed that the paint had not lost its insecticidal properties.

Small rooms were then painted with a D.D.T. paint, and by a fortuitous mistake the oil-bound water-paint used contained only 0·5 per cent of D.D.T.—exactly one tenth the amount used in the laboratory experiments. It was then found that 90 per cent kills of houseflies were obtained overnight as compared with negligible kills in an identical room painted with the oil-bound water-paint containing no D.D.T. It has proved difficult to obtain accurate and reproducible data for the distribution of the flies on the various surfaces of the room, but our preliminary observations indicate that the flies tended to avoid contact with the D.D.T.-painted surface. Our experiments continue with oil and resin media, and there is already evidence that in certain continuous film-forming media D.D.T. retains its insecticidal effect.

The results now being obtained in a factory canteen painted with this D.D.T. oil-bound water-paint are fully supporting the results obtained in the laboratory and laboratory-field experiments. The social implications of these findings need no stressing.

A full account of this work will be published elsewhere.

G. A. CAMPBELL.
Geigy Colour Co., Ltd.,
T. F. WEST.
Stafford Allen and Sons, Ltd.,
London, N.1.

[1] See reviews by West, T. F., and Campbell, G. A., *Indust. Chem.*, **20**, 461 (1944); *Chem. and Indust.*, **36**, 319 (1944).

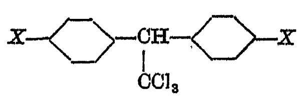
[2] Bushland, R. C., McAlister, L. C., Eddy, G. W., and Jones, H.A., *J. Econ. Ent.*, **37**, 126 (1944).

[3] Madden, A. H., Lindquist, A. W., and Knipling, E. F., *J. Econ. Ent.*, **37**, 127 (1944).

[4] British Patent Application 1943.

## Insecticidal Action of D.D.T.

A STUDY of the insecticidal properties of D.D.T. (αα-bis (4-chlorphenyl)-βββ trichlorethane; I, $X$=Cl) and its analogues, carried out in this laboratory,



(I)

has led to a working hypothesis on their mode of action which has enabled the prediction of insecticidal activity in related compounds.

Although D.D.T. is chemically unreactive and stable to long boiling with water, it readily loses hydrochloric acid to alcoholic alkali or on heating to form αα-bis(4-chlorphenyl)-ββ-dichlorethylene. This compound as well as 4 : 4′-dichlorbenzophenone and bis(4-chlorphenyl) acetic acid are almost inactive both as contact and stomach insecticides, indicating that the $>CH-CCl_3$ group is associated with insecticidal activity.

It is possible that the toxicity of D.D.T. is due to its chemisorption at vital centres, with interference with essential enzyme systems. In view of its chemical inertness, however—for example, no evidence of compound formation between D.D.T. and either the 'acceptor' phenolic hydrogen of the naphthols or the 'donor' nitrogen of the naphthylamines was obtained from melting-point curves—the alternative hypothesis of the intracellular decomposition of D.D.T. is preferred. As the ethylene derivative is non-toxic although presumably sharing the permeativity

of D.D.T., the toxicity of the latter is ascribed to the hydrochloric acid simultaneously produced either by elimination or reduction.

The insecticidal activity of a compound to which this hypothesis is applicable would then depend on the ease with which hydrochloric acid is produced, provided that the compound is stable enough to survive translocation to its site of action. Preliminary work has shown that some other compounds, for example, certain chlorinated cyclic polymethylenes and non-aromatic substituted ethanes susceptible to this decomposition are insecticidal, whereas related compounds from which hydrochloric acid elimination is not possible are inactive.

On the other hand, diphenyl trichlorethane (I, $X = H$) loses hydrochloric acid readily to alkali yet is relatively non-insecticidal. An additional factor, lipoid solubility of the molecule as a whole, is therefore operative. The chlorphenyl groups of D.D.T. would be expected to confer high lipoid solubility and thus high permeativity. The more polar dihydroxy derivative (I, $X = OH$) and its diacetate, with lower lipoid solubilities, are less insecticidal than the dimethyoxy-analogue of D.D.T. (I, $X = OMe$).

Fuller details of this work will be published elsewhere.

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## Experimental Corroboration of the Mechanism of Biological Action of Quinones of the Type of Vitamin K

A HYPOTHESIS was suggested[1,3] in the course of chemical and biochemical studies of the anti-hæmorrhagic compounds that the activity of the quinones of the vitamin K group is due to their bio-oxidative decomposition to phthalic acid and is largely a function of their capacity for transformation into this acid. It is phthalic acid that is apparently to be regarded as the carrier of the biological properties of such quinones.

These statements were based on the following experimental evidence. (1) The quinones of the type of vitamin K are extremely liable to transformation into phthalic acid merely when warmed with water[2]. (2) The structural peculiarities of quinones that give them anti-hæmorrhagic activity are also responsible for their capacity for transformation into phthalic acid[3]. (3) The transformation of such quinones into phthalic acid is linked with the capacity of their molecules for tautomeric transition to a peculiar alycyclical system which is easily oxidizable into phthalic acid[1,2,3]. (4) It was found, on the other hand, that phthalic acid itself possesses a weak[4], and some of its derivatives, for example, diethylphthalate[3], a significant, anti-hæmorrhagic activity. The smaller activity of phthalic acid as compared with diethylphthalate as well as with quinones of the vitamin K type is presumably due to the rapid excretion of this acid from the organism (for details cf. ref. 3). (5) The quinones of the vitamin K type undergo very rapid changes in the blood (cf. J. V. Scudi and R. P. Buchs[5]), although their anti-hæmorrhagic action is known to appear only after a considerable lapse of time. This likewise suggests that these quinones apparently do not circulate within the organism as such at the moment when the anti-hæmorrhagic action becomes manifest, and that the effect at issue is elicited not by these substances but by the products of their transformation.

It occurred to us that one of the most conclusive pieces of evidence supporting the above suggestions as to the mechanism of biological action of the quinones of the vitamin K type would be their transformation within the organism into phthalic acid. It seemed, therefore, worth while to study the metabolism of both phthalic acid and of 2-methyl-1,4-naphthoquinone (the so-called vitamin $K_3$) in the dog and man.

Upon repeated subcutaneous administration to dogs (weighing 12–13 kgm.) of appreciable doses of a rather concentrated aqueous solution of a bisulphite derivative of 2-methyl-1,4-naphthoquinone (total dose about 0·8 gm.) phthalic acid was isolated from the urine and afterwards identified as phthalic anhydride. Urine was shown to lack both 2-methyl-1,4-naphthoquinone and its bisulphite derivative as well as 2-methyl-3-oxy-1,4-naphthoquinone (phthiocol). Phthalic acid was also found in human urine upon subcutaneous injection of 50 mgm. bisulphite derivative of 2-methyl-1,4-naphthoquinone dissolved in water. Nevertheless, phthalic acid itself as well as its di-sodium salt are practically completely excreted after subcutaneous injection of an aqueous solution both in man and the dog without undergoing any changes. This was shown by J. Pohl[6] in the dog and by us in man. The urine of a control man or dog does not contain phthalic acid at all. Hence it follows that phthalic acid is the metabolic end product of 2-methyl-1,4-naphthoquinone.

Thus, our previous hypothesis as of the mechanism of biological action of quinones of the vitamin K group is substantiated not only by the anti-hæmorrhagic activity of phthalic acid but also by the capacity of such quinones for transformation into phthalic acid both *in vitro* and *in vivo*.

Mention must also be made of the publication by K. P. Link *et al.*[7] on the mechanism of the hæmorrhagic action of 3,3′-methylene-4,4′-dioxydicumarin, which is an antagonist of vitamin K. It was shown by these authors that salicylic acid possesses the same type of biological action as 3,3′-methylene-4,4′-dioxydicumarin. As the former is apparently the metabolic product of the latter, it may be regarded as the carrier of its hæmorrhagic functions.

These data become particularly interesting if we recall that, according to our finding, phthalic acid is not only the metabolic end-product of quinones of the vitamin K type, but obviously also the carrier of their anti-hæmorrhagic function.

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[1] Shemiakin, M. M., Schukina, L. A., and Shvezov, J. B., *Nature*, **151**, 585 (1943).
[2] Schukina, L. A., Shvezov, J. B., and Shemiakin, M. M., *J. Obschei Khimii*, **13**, 327 (1943).
[3] Shemiakin, M. M., Schukina, L. A., and Shvezov, J. B., *J. Obschei Khimii*, **13**, 398 (1943).
[4] Pakendorf, K. G., Kudriashev, B. A., and Lasareva, E. N., *Doklady Akad. Nauk U.S.S.R.*, **31**, 484 (1941).
[5] Scudi, J. V., and Buchs, R. P., *J. Biol. Chem.*, **144**, 599 (1942).
[6] Pohl, J., *Biochem. Z.*, **16**, 68 (1909).
[7] Link, K. P., Overman, R. S., Sullivan, W. R., Huebner, Ch. F., and Scheel, L. D., *J. Biol. Chem.*, **147**, 463 (1943).

## Specialized Analgesic Effects of β-Hydroxy-α : β-diphenylethylamine

CLINICAL trials by other workers not yet reported have confirmed our original observation[1] that β-hydroxy-α : β-diphenylethylamine will relieve pain due to pressure on nerve in patients with inoperable tumours. This was the only type of pain included in our trials, and it is now clear that the compound has no universal analgesic action and cannot be used generally as a substitute for morphine. Tests using the method of Sivadjian[2], which measures the tolerance of rats to electric shocks, have now been carried out with morphine and the diphenylethylamine compounds the morphine-like properties of which we have described[1]. The results, which will be reported in detail elsewhere, were entirely negative for the diphenylethylamine compounds; but analgesic activity was demonstrated in the hydrochlorides of morphine and pethidine, showing that the negative results were not due to the method used. The cause of the specific action of β-hydroxy-α : β-diphenylethylamine on nerve pressure pain awaits further pharmacological investigation.

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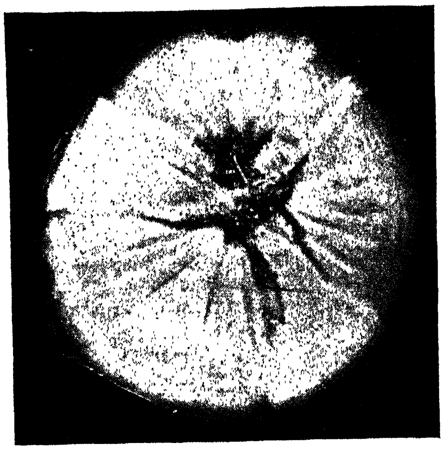
[1] Dodds, E. C., Lawson, W., and Williams, P. C., *Nature*, **151**, 614 (1943); *Proc. Roy. Soc.*, B, **132**, 119 (1944).
[2] Sivadjian, J., *Arch. Int. Pharmacodyn.*, **52**, 142 (1935).

## Genetic Proof of Heterokaryosis in *Penicillium notatum*

IN a recent paper, Baker[1] has given an account of nuclear behaviour in *Penicillium notatum*. We had, independently, reached the same conclusions, summarized as follows: (*a*) the older 'cells' of the mycelium, the sterigmata and the conidia are usually uninucleate; (*b*) the 'cells' at the growing edge of the colony are usually multinucleate, containing up to a dozen nuclei each; (*c*) hyphal fusions occur between branches of the same hypha and also between hyphæ of different origin. From her cytological work, Baker infers that *P. notatum* is liable to be 'heterokaryotic', that is, may carry genetically unlike nuclei in a multinucleate cell, or in different cells of a hypha. This condition, widespread in fungi, well deserves careful investigation in view of its important implications for the theories of gene action and of the evolution of genetic systems. Some of these implications have been discussed by Hansen[2], Dodge[3], Lindegren[4] and, especially, by Beadle and Coonradt[5].

The above cytological inference, in the case of *P. notatum*, needs the support of a genetic counterproof: this can now be supplied. Even though *P. notatum* has no known sexual stage involving alternation of karyogamy and meiosis, the fortunate circumstance that conidia are uninucleate makes a genetic analysis possible. The technique—an obvious simplification of those used[3,5] for species with a sexual stage and multinucleate conidia—is as follows: (1) production by X-rays of mutant strains; (2) mixed inoculation two by two of different mutant strains; (3) search for non-mutant ('wild type') patches, or



MIXED COLONY OF TWO WHITE STRAINS SHOWING GREEN HETEROKARYOTIC PATCHES AT THE CENTRE AND ALONG THE LINES OF CONTACT BETWEEN THE TWO STRAINS.

for patches differing from either strain, at the centre of the mixed colony and along the radii where the mycelia of the two strains are in contact. The following are the results of mixed inoculation two by two of five such X-ray induced mutants, all characterized by a reduced pigmentation of conidia or by complete failure to form conidia. The formation of patches with wild type (green) conidia, or with conidia differing from those of either parental strain, is represented by +, and failure to form such patches by —.

| Designation of strain | Type of conidium | Results of mixed inoculation | | | | |
|---|---|---|---|---|---|---|
| | | *y*—1 | *w*—16 | *w*—2 | *w*—3 | 2*C*4 |
| *y*—1 | yellow | — | + | + | + | — |
| *w*—16 | white | | — | +* | + | — |
| *w*—2 | white | | | — | + | — |
| *w*—3 | white | | | | — | — |
| 2*C*4 | no conidia | | | | | — |

* Very pale green conidia.

All combinations of any two of the first four strains, and none of the combinations involving the non-conidial strain 2*C*4, produce patches of mycelium with green conidia, or with conidia differing from either of the strains used (see accompanying reproduction). When these conidia are plated out, the two component strains are recovered, thus confirming that fusions between hyphæ of the two strains had taken place, followed by migration of nuclei from one strain to the other, and the nuclei segregated later. Segregation of parental nuclei does not take place at the formation of the conidiophore but at some stage between this and the formation of conidia, probably at the formation of the sterigmata. In fact, even though each conidium gives rise to one or the other parental type, both types may be recovered from different conidia of the same (green) penicillus.

Points of interest are, first, that despite the fact that each conidium carries a single nucleus, all those of one penicillus are uniform in their pigmentation: hence this pigmentation is controlled not by the genetic constitution of the nucleus segregated into each conidium, but by the constitution of the hypha from which the penicillus arose. Secondly, if the familiar criteria of genetics are valid in the present case, four out of the five X-ray mutations tested, namely, *y*-1; *w*-16; *w*-2; *w*-3, behave as if they were recessive, involving four different loci. As for the fifth mutation—the non-conidial 2*C*4—failure to produce green conidia in mixed inoculi is probably due to dominance of the non-conidial effect, as inter-

strain hyphal fusions have been seen to occur also with this strain. Should this inference be confirmed, the high frequency with which non-conidial mutants have been found, even without irradiation[6], would simply be the consequence of dominance.

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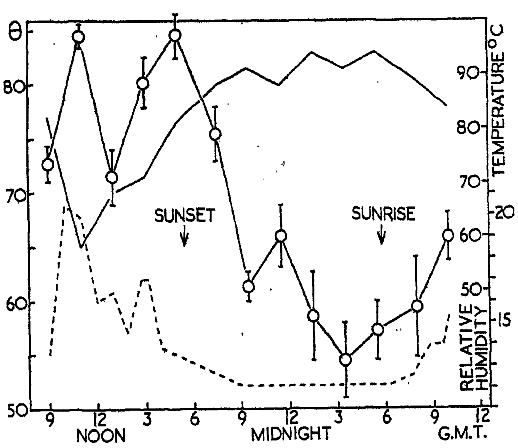
1 Baker, G. E., *Bull. Torrey Bot. Club*, **71**, 367 (1944).
2 Hansen, H. N., *Phytopathology*, **32**, 639 (1942).
3 Dodge, B. O., *Bull. Torrey Bot. Club*, **69**, 75 (1942).
4 Lindegren, C. C., *J. Genet.*, **28**, 425 (1934).
5 Beadle, G. W., and Coonradt, V. L., *Genetics*, **29**, 291 (1944).
6 Hansen, H. N., and Snyder, W. C., *Science*, **99**, 264 (1944).

## Diurnal Fluctuation in a Physical Property of Leaf Cuticle

The extent to which the outer surface of a leaf is wetted by water may depend on factors varying with species, age, and position on the plant. A series of investigations on advancing contact angles has made it clear that, in addition, the adhesion of water for leaf surfaces may vary considerably with the condition of the leaf, and, in particular, with factors showing a cyclic diurnal change.

Measurements made at intervals over periods of up to 26 hours have shown the existence of distinct diurnal fluctuations in the magnitude of the advancing contact angle of water on the leaves of the two plant species so far investigated from this point of view. Contact angles were determined by a method similar to that of Ebeling[1], in which a value is derived from the characteristics of the curve obtained by tracing the projected profile of a drop resting on a horizontal surface. The accompanying graph represents results obtained with *Brassica sinapis* Visiani growing in an outdoor plot. Contact angle increased after dawn, reaching a maximum in the afternoon and falling after sunset to a minimum before sunrise. The difference between the two extremes was of the order of 30°. In other experiments contact angle has been observed to rise again to a second maximum after the minimum occurring about four hours after sunset, afterwards falling once more to a low value




Diurnal fluctuation in the advancing contact angle of water (θ) on the upper surface of leaves of *Brassica sinapis* Visiani growing in an outdoor plot (September 1943). Each value is the mean of ten determinations, the standard deviation of the mean being indicated. Contact angle, ——O——; relative humidity (by whirling hygrometer), ———; temperature, - - - - -.

just after dawn. Essentially similar fluctuations through a smaller range (6–9°) have been found to occur in *Triticum vulgare* Host. under both greenhouse and outdoor conditions. When the two species have been compared, the changes in contact angle of *Triticum* have been found to parallel very closely those of *Brassica*.

In detached leaves the effect of temperature has been found to be negligible; but a marked rise in the value of contact angle has been observed in wilting leaves and it appears that the water relations of the leaf are of considerable importance in determining its magnitude. The following results were obtained using the upper surface of leaves, removed in the morning from young *Triticum* plants, left to dry out under laboratory conditions of temperature and humidity. Control leaves, kept from the start of the experiment with their cut ends immersed in water, showed no statistically significant change in the characteristics investigated. Each value for contact angle is the mean of nine determinations.

| Time in hours | 0·0 | 0·5 | 1·0 | 1·5 | 2·0 | 2·5 | 4·0 |
|---|---|---|---|---|---|---|---|
| Mean contact angle for water (θ) | 123·7° | 128·6° | 133·2° | 138·3° | 141·6° | 145·2° | 152·4° |
| Standard deviation of θ | 2·0 | 2·2 | 1·9 | 1·1 | 1·7 | 0·8 | 2·7 |
| Wt. of leaves as % of initial value | 100·0 | 96·0 | 92·1 | 86·2 | 84·5 | 82·4 | 72·0 |

Such a change in contact angle is fully reversible on recovery of turgor. Thus the contact angle of water on *Triticum* leaves rose on wilting for three hours from 117·7° ± 2·3 to 146·0° ± 0·8, but returned to 118·4° ± 2·4 after the leaves had stood with their cut ends in water for a further three hours. Water applied directly to the surface of the leaf appears to be ineffective in restoring the low value of contact angle.

The contact angle of water on wilted or turgid leaves stretched uniformly has been found not to differ appreciably from that on similar unstretched leaves. It seems unlikely, therefore, that the observed changes in the surface properties of the cuticle can be due simply to alteration in the closeness of packing of hydrophilic or hydrophobic units, produced by expansion or contraction in response to turgor changes. Variation in the extent of water-imbibition of the cuticle is possibly of more importance in determining the magnitude of contact angle.

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1 Ebeling, W., *Hilgardia*, **12**, 665 (1939).

## Wilting of Shoots in Scented Geranium (*Pelargonium odoratissimum*)

*Pelargonium odoratissimum* Ait. (scented geranium) is a perennial trailing herb extensively cultivated for the essential oil present in the leaves, which is used as a cheap substitute for the attar of roses. Large numbers of these plants growing in Bangalore were parasitized by a species of *Sphæropsis* which caused the wilting of the shoots. When the infection extended up to the collar region it resulted in the death of the entire plant.

A detailed microscopic and cultural study of the fungus was undertaken and the pathogenicity of the

infecting organism was established. The pycnidia on the shoots are numerous, appearing as black specks on the surface of the shoot. The mycelium is purplish-black, intercellular and causing the death of the host cells. The size of the pycnidium is variable, and sometimes on account of coalescence they appear locular in sections. The spores are glassy, hyaline, ovate to cylindric, and measure 18–24 × 11–14 µ. In moist weather the spores emerge out of the long narrow ostiole (Fig. 1) and become brown after they are extruded from the pycnidium. Later on they become '*Diplodia*'-like, the exospore being traversed by longitudinal hyaline streaks (Fig. 2). The spores readily germinate and cause further infection of the host.

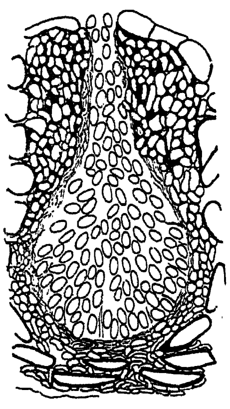

Fig. 1.

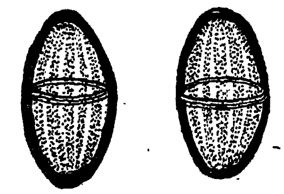

Fig. 2.

The time of colouring of the pycnospores is shown by Stevens[1] to be an important diagnostic character. He further points out the folly of attempting to decide matters relating to the life-history of this group of fungi on the basis of the association of the host[2]. Since most of the fungi belonging to this group are present on more than one host their identity becomes a matter of extreme difficulty. Recently Da Camara, De Oliveira and Da Luz[3] have recorded *Sphæropsis Pelargonii* as a new species on the shoots of *Pelargonium zonale*. Since the type of the species was not available for comparison, it was not possible to decide the identity of the *Sphæropsis* species under investigation.

I wish to express my grateful thanks to Dr. B. B. Mundkur, for help with the literature, and to Dr. L. N. Rao, for kind encouragement.

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[1] Stevens, N. E., *Mycologia*, **25**, 536 (1933).
[2] Stevens, N. E., *Mycologia*, **28**, 330 (1936).
[3] Da Camara, E. de S., De Oliveira, A. L. B., and Da Luz, C. G., *Rev. agron. Lisboa*, **24**, 37 (1936) (original not seen).

## Influence of Ultra-Violet Radiations on the Etching of Quartz

EXPERIMENTS have been carried out to investigate the influence of ultra-violet radiations on the etching of quartz by hydrofluoric acid. The quartz plate under investigation is subjected simultaneously to the actions of the corrosive acid and the ultra-violet radiations. The etching cell used consists of a short pitch-coated glass tube of which the quartz plate under study forms the bottom. The inner surface of the plate is in contact with the acid while the rim of its polished outer surface is covered by a paper ring. In this way, the ultra-violet radiations which penetrate the plate from underneath will irradiate only the central portion of its inner surface. With such a device, the two parts of an etched surface, one subjected to, and the other protected from, the action of ultra-violet radiations, can be conveniently compared. The strong ultra-violet radiations used come from a 'condensed' discharge between two iron electrodes. They are focused on the base of the etching cell by means of a quartz lens. Plates cut in different orientations and plates of amorphous fused silica have been investigated. With a moderately strong acid, the duration of each experiment lasts generally about eight hours.

(1) *Plate normal to the optic axis.* For plates of this orientation, there is a marked difference in many respects between the two portions etched. Irrespective of the original surface condition, that is, whether it is polished or unpolished, the irradiated part becomes practically transparent shortly after the introduction of hydrofluoric acid into the etching cell, while the other part becomes completely mat as usual. On examining the etched surface under a microscope, it is observed that the characteristic etching figures, namely, the well-known projecting triangular pyramids, are present in both etched portions, but with different aspect; those produced in the irradiated portion are notably flattened and changed in orientation. The transparency of this portion is undoubtedly due to the flattening of the etching figures. The sense of change of orientation of the deformed pyramids depends upon the nature of the crystal. Relative to the orientation of the normal pyramids, it is anti-clockwise for right-handed quartz, but clockwise for left-handed quartz. The angle of change of orientation increases with the intensity of the source, and an angle so large as 15° has actually been observed. In this connexion, it should be pointed out that the dissolution of quartz in the corrosive acid is far greater in the irradiated portion; this can be easily verified by comparing the depression of the surface-levels of the two etched portions. All the phenomena mentioned above will disappear if a glass plate, even as thin as 0·5 mm. in thickness, is interposed between the light source and the etching cell. A spectroscopic examination shows that the glass plate absorbs all radiations of wave-lengths shorter than some 2800 A. Hence it is clear that the observed effects on etching are due to the short wave-length radiations lying beyond this limit of absorption.

(2) *Plates of other orientations and of fused silica.* Under similar experimental conditions, the micrographic structures of the irradiated and the non-irradiated etched portions of an $X$-cut or $Y$-cut plate are almost the same, the two portions being barely distinguishable in a reflecting light. As to the fused silica plate, it is impossible to make a distinction either microscopically or macroscopically between the two etched portions in question.

The close relation between the axes of quartz and the orientation of the triangular etching pyramids has long been recognized. Recently, A. de Gramont[1] has found that the angle formed by the three faces of a pyramid of corrosion with the plane normal to the optic axis is about 29°. It was pointed out by J. B. Eck and J. Menabrea[2] that the tangent of this angle is nearly equal to the ratio $c/2a$, where $c = 5{\cdot}38 \times 10^{-8}$ cm., which represents the height of the hexagonal lattice, and $a = 4{\cdot}89 \times 10^{-8}$ cm. represents the distance between the axes of the adjacent spirals. Should this equality be not due to a fortuitous coincidence, the flattening and the change

of orientation of the elementary pyramids might be regarded as evidence of some modification of the crystalline structure by the action of the ultra-violet radiations.

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* In orthodox romanization, Chung Shêng-Piao.

[1] de Gramont, A., *Rev. d'Optique*, **10**, 213 (1931); and "Recherches sur le Quartz Piezoelectrique" (1935), 31.

[2] Eck, J. B., and Menabrea, J., *C.R. Acad. Sci.*, **200**, 1610 (1935).

## A Solar Halo Phenomenon

SIMILAR phenomena to those described by G. H. Archenhold[1] were observed in France during the War of 1914–18 near the fighting zone, and there are records of similar waves observed during this War[2]. Some of the records are, however, scattered in publications not accessible to me at the present time.

A probable explanation of this phenomenon is that it is caused by acoustic waves from explosions passing through a cloud of ice crystals. The explosions might be so distant that they may not necessarily be heard at the point of observation. The perfect straightness of the bands observed by Archenhold supports this view of their distant origin. The observed very high velocity of about 5° per second agrees well with the velocity of sound at the height at which ice clouds are forming. The spacing of the bands of ½–1°, when compared with their speed, corresponds to the frequency of 2·5–5 cycles per second, which also corresponds to the fundamental frequency of sound caused by heavy explosions.

Ice crystals floating in air are usually oriented with their greatest cross-section perpendicular to the direction of the field of gravitation, that is, platelets have their six-fold axis of symmetry vertical, needles have it horizontal. The mock sun ring is usually produced by the reflexion of light on the vertical side faces of the plates, but it might be produced sometimes by the vertical end faces of the needles. The passage of the sound waves through the cloud would produce a movement of the air relative to the crystals, due to their inertia. This would have also an orienting influence on the floating crystals, which should tend to orientate themselves with their greatest cross-sections perpendicular to the direction of the sound. The presence of the sound waves will thus disturb the vertical orientation of the crystals, and dark bands would appear in the reflexion halo approximately in the zones of maximum acceleration of the sound waves, that is, there will be two fringes for each wave-length.

The disturbances could not be explained as due to the discontinuity of the wind speed at the surface of contact of two different air masses, as such disturbances usually travel at considerably lower speeds than the speed observed by Archenhold.

It would be of great value if any additional information could be procured concerning the height of the aeroplane cloud trails formed during August 9 (not necessarily at Cambridge), and concerning any heavy explosions heard south of Cambridge.

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[1] Archenhold, G. H., *Nature*, **154**, 433 (1944).

[2] *Flight*, Aug. 8, 1940. *Times*, Aug. 31, 1944.

THE phenomenon of moving dark bands travelling across a solar halo, as reported by Mr. G. H. Archenhold[1], seems to be linked with the optical effect of blast such as results from the explosion of bombs, etc.

An account of moving dark bands passing across cirrus cloud was given by a special correspondent of *The Times* in the issue of August 31, the date of the occurrence being August 9, and the locality of the observance of the occurrence as southern England.

It would be interesting to know from Mr. Archenhold whether any gunfire was heard on the morning in question.

The optical effects of blast from flying bombs have been reported by other observers and myself within recent weeks and have appeared in the columns of *Engineering*, *The Aeroplane* and *The Times*.

In my own experience, the moving dark bands have been observed on very low stratus cloud.

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[1] *Nature*, **154**, 433 (1944).

## Abnormal Paranthelia

TWICE within the last year I have observed a paranthelion bearing about 165° from the sun—a position in which the paranthelion does not seem hitherto to have been reported.

The features common to the two appearances were as follows. The sky in the neighbourhood of the phenomenon was a dilute blue with wisps of cirrus. A region of the sky, covering about 3° of altitude and 5° of azimuth, was singled out by the fact that whenever a wisp of cirrus drifted into it the cloud became brilliantly luminous, without colour, and remained so until it left the region; blue sky within the region was not differentiated from that without. The centre of the region was, as nearly as could be estimated by eye, at the same altitude as the sun and approximately 15° eastward of the position which would have been occupied by the anthelion, had one been present. There was, however, no trace of anthelion, nor of any other paranthelion. Each appearance lasted some twenty minutes from the time of first observation.

The distinguishing details were as follows.

| | I | II |
|---|---|---|
| *G.C.T. of first observation* | 11.50; Sept. 24, 1943 | 11.10; Aug. 9, 1944. |
| *Place* | Moulsford Down (51° 32′ N., 1° 11′ W.) | Reading (51° 26′ N., 0° 57′ W.). |
| *Sun's altitude (computed)* | 38½° | 53½°. |
| *Bearing of centre of luminous region* | 160–165° E. of sun. | 165–170° E. of sun. |
| *Weather* | Brilliant sunshine; no cloud beyond that described below; sky-blue very little diluted; wind S.W., force 2 at ground; some cumulus blew up shortly afterwards. | Bright sunshine; much cirrus; lower cloud types in other parts of sky; sky-blue much diluted; wind N.W., force 1 at ground. |
| *Other contemporary meteoroptical phenomena* | None. | Traces of parhelic circle between 100° and 160° E. of sun. |

On occasion I no other meteoroptical phenomena were seen on the same day. On occasion II, Mr. R. Adcock and Mr. M. Barker, who directed my attention to II, reported having seen a parhelion (III) (? colourless), 46° E. of sun, at 9.15 G.C.T. on the same day. Unfortunately, no instruments were available for any of these observations, so that the azimuths are rather uncertain; III was carefully aligned on marks which were measured later.

It has been suggested that the increased frequency with which haloes and parhelic phenomena, especially of the rarer types, have been observed of recent years is due to some special tendency of condensation trails from aircraft to crystallize in the appropriate manner. Trails were being formed in other parts of the sky before and during the observation of II and III, but the clouds manifesting the paranthelion were not seen to be formed from them and had the general appearance of natural cirrus. No trails were noted on occasion I, but the clouds, which were of normal cirrus texture, had an unusual disposition. Some eight to ten dense, parallel bundles of cirrus wisps, somewhat entangled, evenly occupied a rhombus of about 20° side, outside which the sky was conspicuously cloudless.

I am unable to offer any explanation of II. I might possibly be the rare and doubtful paranthelion of 35–38°, set back by the high altitude of the sun. On the basis of Pernter and Exner's[1] tentative theory of this phenomenon, the computed bearing from the sun is 155° (observed 160–165°). Their doubts, however, have special force in this case owing to the high altitude of the sun and the extreme brilliance of the phenomenon. This explanation is quite unacceptable for II (theoretical bearing 179°). III cannot have been the primary parhelion of 46° owing to the high altitude, but might have been the secondary parhelion of 2 × 22°.

I have taken the liberty above of introducing the word 'meteoroptical' in place of 'meteorological optical', which is cumbersome.

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Sept. 30.

[1] Pernter and Exner, "Meteorologische Optik" (1910 edit.), 392.

## Antiquity of Man in Australia

IT was very gratifying to read Prof. F. Wood Jones' article and also Dr. F. E. Zeuner's appraisement of the Keilor skull discovery[1]. In Australia, the significance of the skull has only been appreciated in part, a fact which can largely be explained by preoccupation with the War. Mahoney's scholarly memoir[2] has indicated that, even if his altimetric estimation of the age of the skull is not accepted as final, every endeavour should be made to conserve all relevant data available.

The deposit in which the skull was found is very limited, probably of less than an acre; nevertheless the site of the discovery is still being exploited as a sandpit, and although contemporaneous deposits no doubt will be found, no attempt has been made to preserve the site for a thorough scientific search.

Furthermore, I am given to understand that the sand contractor who found the original skull had in his possession another skull, bones and possibly artefacts, which seemingly will be lost to the scientific world.

Zeuner expresses the hope that "the Keilor discovery will encourage further search for early man in Australia". It is suggested that a more urgent task for Australian science is not so much archæological as anthropological, for in the sociology of the few remaining tribalized aborigines we have the key to our own social evolution which, even if the aborigines themselves do not die out, will, in a matter of a few decades, be irretrievably lost.

The riddle of the world-wide mother-in-law taboo[3] can only be solved by assuming social conditions in the past similar to those of the Australian aborigines, and it has been indicated how man's earliest social evolution must have been determined by the progressive avoidance of incest. The structures of Australian societies show how this avoidance was obtained by the introduction of taboo and exogamy[4].

It is therefore to be regretted that in the southern hemisphere there has been during the past few years a marked swing away from the study of the Australian aborigines towards the study of the more colourful island people to the north of Australia, whose societies will still be virtually intact when those of the Australian aborigines will be, like the Tasmanians, a thing of the past.

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Melbourne.

[1] *Nature*, 153, 211, 622 (1944).
[2] *Mem. Nat. Mus. Melbourne*, 13, 79 (1943).
[3] Jolly and Rose, *Man*, 42 (Jan-Feb. 1942).
[4] Jolly and Rose, *Ann. Eugen.*, 12 (July 1943).

## A New England Naturalist

IN connexion with the interesting and entertaining review[1] by Sir D'Arcy Thompson of Dr. Barbour's book "A Naturalist at Large", it is worth putting on record that the Zoo has had two specimens of the Páca rána (*Dinomys branickii*) from South America during the past twenty years. The first was presented by Mr. Herbert Whitley in June 1925 and the second was purchased from a dealer in September 1929.

At death, both bodies were preserved, the former being sent for dissection to Dr. A. B. Appleton at Cambridge, the latter to Tring Museum at the request of the late Lord Rothschild.

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[1] *Nature*, 154, 411 (1944).

## Photochemistry in Retrospect

DR. IREDALE[1] discusses in his retrospect on photochemistry the surprising fact that Einstein's Law of Photochemical Equivalence seems to be almost forgotten by modern photochemists. This oblivion is still more astonishing if one remembers the role of the law in general chemistry.

From the beginning, it was quite clear that any experimentally established failure of the law in a complete photochemical reaction was due to purely chemical secondary reactions. These are independent of the photochemical primary processes, which are without exception controlled by Einstein's Law. E. Warburg's[2] finding that not one molecule as expected but *two* molecules of hydrogen iodide are decomposed by *one* light quantum led him to the fundamental assumption of the interaction of short-lived hydrogen and iodine atoms in the secondary reaction chain. This chain reaction is the model for all modern conceptions of chemical and photochemical reaction kinetics, which operate with free atoms or radicals.

F. WEIGERT.

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Northwood.

[1] *Nature*, 154, 326 (1944).
[2] *Ber. Berlin. Akad.*, 314 (1916).

# RESEARCH ITEMS

### Blood Sugar Levels in the Bengal Famine

DR. M. L. CHAKRABARTY, at the Campbell Medical School, Calcutta, has measured the blood sugar in a series of starvation cases admitted to hospital during the recent famine. In a communication to *Nature*, he states that some surprisingly low figures were found; the lowest recorded was 20 mgm. per 100 c.c., and this case recovered under treatment. In a normal individual, definite symptoms of hypoglycæmia occur when the blood sugar falls below about 70 mgm. per 100 c.c.; but these starvation cases, although weak and lethargic, with profound depression of all bodily activities, never exhibited any of the typical nervous symptoms of hypoglycæmia in spite of their extremely low blood sugars. The absence of hypoglycæmic symptoms was probably due to the slow and insidious onset of the hypoglycæmia; in such cases of 'chronic' hypoglycæmia it seems that the nervous system has time to adapt itself to the low sugar level. Biochemical investigation of these cases is proceeding and the main interest so far is the demonstration that life can continue, albeit at a low ebb, with a blood sugar of only 20 mgm. per 100 c.c.

### Immunization against Malaria

H. R. JACOBS (*Amer. J. Trop. Med.*, 23, 597; 1943), working on immunization against malaria, has shown that, in ducklings, the subcutaneous injection of saline-insoluble residues of *Plasmodium lophuræ*, mixed with a staphylococcus toxoid, give practically 100 per cent immunity to malaria. The substance used is "an extract of protamide plasmodial precipitate insoluble in saline solution". It appears that such plasmodial substances insoluble in saline contain antigenic material which is effective, and that by addition of bacterial toxin its efficacy could be increased sufficiently to give promise of a wider application. F. F. Schwentker and F. C. Comploier (*J. Exp. Med.*, 70, 223; 1939) have shown that a toxoid combined with a non-antigenic material served to make it antigenic. Jacobs does not claim that immunity is produced, but that effective protection against malaria is obtained; and he feels that the way is opened for the preparation of a good vaccine which will provoke an immunity so powerful that overwhelming doses of the parasites will be neutralized quickly.

### Poisoning by Tetrodon Fishes

WARREN HAROLD YUDKIN in an interesting paper discusses and summarizes information on the poisoning properties of the Tetraodontidæ or puffer fishes (Tetrodon Poisoning. *Bull. Bingham Oceanographic Coll.* Peabody Museum of Natural History, Yale University, 9; 1944). Poisoning by various fishes belonging to this family has been known for centuries and much has been written about it, as is shown in the present paper. A certain amount of research has been done, especially by the Japanese on species of *Tetrodon*. These fishes are eaten to a large extent in Japan and a number of people die of poisoning every year. Macht and Spencer (1941) have recorded interesting work done on *Spheroides maculatus*, the Atlantic puffer. This fish has recently attained market status as a result of the increased utilization of 'trash fish'. Evidence is provided that toxic substances of many Tetraodontidæ are located chiefly in the gonads and liver and may vary with the breeding seasons. *Spheroides maculatus* has been eaten for some time in various regions, with few, if any, reports of ill-effects, and it is probable that when properly cleaned it is not ordinarily toxic. Experiments are now being conducted at the Bingham Oceanographical Laboratory on this fish to ascertain whether it can be toxic under certain conditions, and it is strongly recommended that similar detailed researches should be made in other localities.

### Diphyllobothriidæ in the South Wales Trout

FURTHER reference to the occurrence of larval stages of Diphyllobothriidæ in trout in South Wales and in the Dublin area (see *Nature*, Aug. 5, p. 185, and Aug. 26, p. 267) is made by K. Unsworth (*Brit. Med. J.*, 385, Sept. 16, 1944), who says that a full account of the life-cycle of the parasite found in the trout in South Wales will be published in the near future. The life-cycle has now been successfully completed experimentally in the dog, with *Cyclops* and the stickleback (*Gasterosteus aculeatus*) as intermediate hosts. Discussing the view of M. D. Hickey and J. R. Harris that cormorants and seagulls are the naturally infested definitive hosts of the parasite in the Dublin area, Unsworth suggests that the trout in South Wales were infested with two distinct species, one of which develops in an avian and the other in a mammalian host.

### Naked Pigeons

"PIGEON courtship, with its strutting, cooing and puffing out of feathers is an interesting performance. When there are no feathers to puff or to clothe the performer it becomes a ludicrously macabre travesty of a dance." L. Cole and R. D. Owen (*J. Hered.*, 35, 3; 1944) describe such a case which results from a simple recessive gene. The accompanying photographs suggest a complete picture of the Dodo in "Alice in Wonderland". The interest of the case is that all the normal reactions of attempting to fly, to parade before the female and to fight with the wings are present. As a result of the absence of feathers the birds do not retain the heat and must be kept in artificial warmth; they are infertile as males since they are unable to balance properly in mating. Artificial insemination has been successful, but is laborious. There was no inferiority complex shown by featherless pigeons and artificial clothing was deeply resented.

### Occurrence of Epilepsy in Cattle

A YOUNG brown Swiss bull showed signs of epilepsy at six months old. Tongue chewing, slight foaming at the mouth and collapse in coma were the chief symptoms. Injections of calcium gluconate relieved the symptoms in about fifteen minutes. F. W. Atkeson, H. L. Ibsen and F. Eldridge (*J. Hered.*, 35, 45; 1944) describe this case and the progeny derived from this bull. There were thirty-seven offspring, of which twenty-three were apparently normal, thirteen were epileptic and one died at birth. There are indications that this autosomal dominant is of recent origin. The attacks take place in the first two years of life; as the animal gets older, the intensity and frequency of the attacks varies considerably and in some cases may not be detected.

### Oxidation and Mechanism of Action of Mutagenous Factors

ACCORDING to the current biophysical theory, a mutation caused by X-irradiation is regarded as a

result of direct action of a secondary electron upon an atom in a genetically significant structure. Investigations undertaken by I. A. Rapoport in the Institute of Cytology of the U.S.S.R. Academy of Sciences (*J. Gen. Biology*, Moscow, 4, No. 2; 1943) suggest that the phenomenon may be more complex. It appears that the mutation effect of short-wave irradiation is due to the appearance in the irradiated cell of a substance inducing mutations. Such a substance is possibly ozone, formed in the cell from oxygen as a result of irradiation. Combined action of iron (in the larval food of *Drosophila*) and X-rays resulted in a marked increase in the percentage of mutations. This stimulating effect of iron on the mutation process cannot be explained on the basis of biophysical theory but it accords well with the fact that physiological action of ozone is stimulated by iron. The chemical action of X-rays and of the activated oxygen is similar in some respects. The disturbance of continuity of a chromosome thread due to irradiation may be compared with the rupture of ozonides at the site of the unsaturated bond. The presence of such unsaturated bonds in the chromosome would make it possible to interpret synapsis and crossing-over as phenomena of labile polymerization and depolymerization. Since very active forms of oxygen are formed regularly in the course of normal metabolism, they may constitute an important factor in a spontaneous mutational process.

### Non-Coherent Scattering in Astronomy

A DETAILED review by Spitzer has appeared (*Astrophys. J.*, 99, 107; 1944) of a paper by Houtgast of Utrecht on the variations in profile of strong Fraunhofer lines across the sun's disk, and some remarks are made (*ibid.*, p. 1) by the same author on the theory of non-coherent scattering, stimulated by Houtgast's work. The observational material in Houtgast's paper is by far the most extensive and homogeneous yet obtained; but divergences between the measured profiles and those previously published suggest the presence of systematic differences which may be instrumental or may be real, caused perhaps by variations in solar activity. The centre-limb variations found in the far wings of absorption lines are compared in turn by Houtgast with what would be expected for pure absorption, pure extinction and pure scattering. It is found that coherent scattering does not adequately represent the observations even qualitatively, especially in the ultra-violet lines, for which the absorption wings should vanish towards the limb and be replaced by emission wings close to the limb. It is therefore suggested that the dominant process in the formation of strong absorption lines is non-coherent scattering, a phenomenon which arises when the selectively scattered radiation is first captured in the usual way and then re-emitted with a slightly different wave-length, and which appears as pure absorption in the wings. Spitzer's own investigation shows that non-coherency may be expected to occur, partly or wholly, in the scattering process which forms almost all absorption lines of astrophysical importance. The effect of the process on line profiles is not very large: no major change in the curve of growth is to be expected, but the cores of strong lines will be sharper than predicted on the assumption of coherent scattering, especially away from the limb. This is in qualitative agreement with accurate profiles determined interferometrically for the *D* lines in the sun, and with the sharp cores of the hydrogen lines in *A*-type stars. Further study of this almost unexplored field promises to be interesting.

### Relation between Magnetic Storms and Solar Activity

C. W. ALLEN, Commonwealth Solar Observatory, Canberra, has described a statistical investigation of the influence of solar flares and sunspots on terrestrial magnetic storms (*Mon. Not. Roy. Astro. Soc.*, **104**, 1; 1944). The magnetic data cover the period 1906–42, and up to 1937 international character figures were employed; during 1938–42, *K*-index daily sums were used. In the period 1906–43 there were 2,800 disturbed days, and these were divided into four groups on the basis of recurrence tendency, as shown in 27-day charts. There is some evidence to support the view that great magnetic storms are caused by chromospheric eruptions, the time interval between the eruption and the maximum of the great storm being approximately 1½ days. Eruptions are also responsible for some smaller storms with a 2½-day interval. Smaller storms tend to recur at intervals of 27 days, which betrays their solar origin, and shows that there are regions on the sun's surface, known as Bartel's '*M* regions', not distinguished by any markings, which are associated with these minor geomagnetic disturbances. A period of about three days is required for *M*-region particles to travel from sun to earth. The *M*-region is considered to be an emission coming continuously from almost all the sun's surface, and constrained to move in streams by forces in the sun's atmosphere. The persistence and changes of the recurrent magnetic storms would then be due to the continuity of these streams. A close relationship has been found to exist between sunspots and coronal plumes, though the foci of the plumes do not coincide exactly with sunspots. While the plumes come from areas that in general surround or are close to group spots, the 1919 eclipse did not show this relationship, thus proving that the large groups and spots are not invariably connected with one another.

### Meteor Observations during 1941–42

MOHD. A. R. KHAN (*J. Hyderabad Acad.*, Studies No. 6; 1943) has discussed observations during two years of shower meteors and exceptionally bright meteors. The shower meteors were the Quadrantids, Lyrids, $\eta$ Aquarids, $\delta$ Aquarids, Perseids, Orionids and Geminids. In 1941 the Quadrantids and Lyrids were extremely scarce, only one of each being observed, but the other showers were fairly active. In 1942 moonlight and other hindrances prevented systematic observation of the first four showers, and few of the meteors recorded during the Perseid and Orionid period belonged to either of these showers. In addition to some exceptionally bright meteors emanating from the showers referred to, 28 more were observed during the two years. In 1941 during a watch totalling 57h. 02m. over 114 nights, 914 meteors were seen, and in 1942 a total of 44h. 54m. was spent on 118 nights, during which 710 meteors were seen. The questions of persistence of streaks and of their colour and size are discussed. Dryness of the air, like clearness or dust-free conditions, seems to determine the visibility of enduring trains. The author's observations lead him to conclude that the drier the air is in certain regions the more likely will enduring streaks be seen. In addition to this factor, it is suggested that the electrical condition of the upper atmosphere is also important, because it is known that ionization plays a very important part in the development of meteor trains.

# SURFACE TENSION AND THE DEGENERATION OF NERVE FIBRES

By J. Z. YOUNG
Magdalen College and Department of Zoology, Oxford

A NERVE fibre is an immensely elongated cylindrical cell the content of which is a viscous fluid. Around it there is often a semi-fluid covering, the myelin. Now Plateau[1] showed that a cylinder of liquid only remains stable under its surface tension if its length is less than its circumference. High viscosity and other factors may allow cylinders of somewhat greater length, but as the length is increased a point is reached at which small deformations are not corrected by the surface tension, which rather causes the cylinder to acquire an unduloid outline and break into droplets. Instances of the operation of this principle are common in Nature[2]; for example, the protoplasm of plasmolysed root hairs assumes an unduloid form.

There are many indications that such surface forces operate in nerve fibres. For example, during the degeneration of the peripheral section of a severed nerve fibre the myelin and axon lose their cylindrical shape and form a series of ovoid segments. The first sign of this 'degeneration' is the assumption of an unduloid outline by the myelin, followed by a breaking into segments, long at first, then shorter and shorter, until a series of spherical droplets remains. The process goes on very slowly and in a rabbit's nerve examined three or four days after severance all stages can be seen. During the separation of the segments a neck is first formed, and this then breaks to form 'Plateau's spherules', which appear with a regularity almost equalling that of the experiments which Plateau himself and Darling[3] made with equidense liquids (Fig. 2).

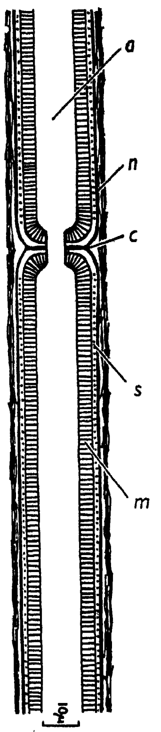


Fig. 1. Diagram of a longitudinal section of a portion of a peripheral nerve fibre; *a*, axon; *m*, myelin; *n*, neurilemma; *c*, 'cementing disc' at node; *s*, protoplasm of Schwann's cell.

The situation is of course complicated by the fact that the axon and myelin are enclosed in a tube composed of the protoplasm of the cell of Schwann and the neurilemma and endoneurium (Fig. 1). The last two form a wall which is moderately rigid and little elastic. The Schwann cell forms a fenestrated membrane between the myelin and the neurilemma. It seems probable that the tube wall as a whole is permeable to water, and that the myelin does not wet it. There is therefore little difficulty in the formation of new surfaces and segmentation of the contents of the tube.

If surface tension causes the isolated nerve fibre to break up, what is the force emanating from the cell body which normally maintains its integrity? It was suggested[4,5] that the fact that material flows from the central but not the peripheral end of a severed nerve fibre indicates that there is an intra-axonic turgor pressure and flow. Weiss[6] has recently adopted a similar view in showing that there is a continual growth of axons, leading to a damming of axoplasm behind a constricted point on a nerve. No one has yet actually measured the rate of movement of the axoplasm; but it seems likely that it takes place continually, if slowly, presumably forcing out material over the surface of tho fibre. It is possible that it is the resulting pressure, blowing up the fibre from inside, which maintains the cylindrical outline against the surface tension forces. If this is correct it might be possible to prevent degeneration in a peripheral stump by providing a substitute for the normal pressure.

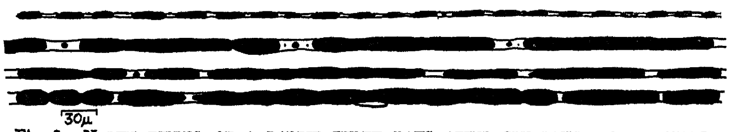


Fig. 2. Nerve fibres of a rabbit three days after severance, seen after staining with osmium tetroxide. Note unduloid outlines and separation into ovoids with primary and secondary Plateau's spherules between.

The tendency to assume an unduloid outline is certainly very strong, and probably operates even during the normal life of a nerve. Fibres teased carefully in Ringer's fluid show various degrees of departure from a strictly cylindrical shape. There is a close topographical relationship between the unduloids and the incisures of Schmidt-Lanterman (Fig. 3). These oblique cracks in the myelin always lie in the region of concavity of a wave. Now the myelin consists of coaxial sheets of orientated phosphatide and protein molecules[7], and in some stages of incisure development the breaking of these lamellæ can be clearly seen, especially in the troughs of the unduloid. Longitudinal stress increases the incisure[8]. The material of the myelin is evidently very peculiar if it can flow and yet break in this way, and further investigation is necessary. Fig. 4 suggests that the broken edges of the lamellæ constitute the 'spiral apparatus of Golgi-Rezzonico' which appears to occupy the cleft.

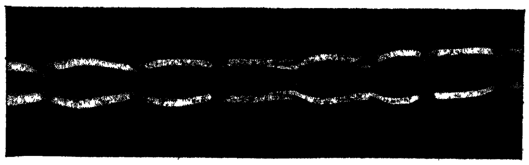

Fig. 3. Nerve fibre of rabbit isolated in Ringer's solution and photographed in polarized light. (× 600.)

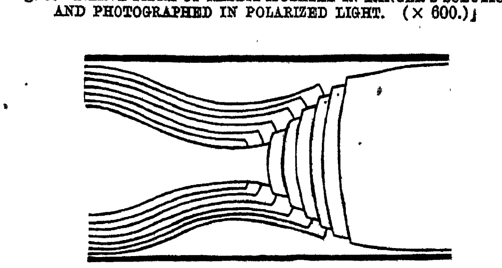

Fig. 4. Diagram to show result of assumption of unduloid outline by a nerve fibre, breaking the lamellæ of the myelin to form an incisure.

Ranvier[9] suggested that the myelin can be considered to be included within its Schwann cell as a fat droplet in a fat cell, and hinted at the possible importance of its surface tension. Several observations indicate that each whole internodal segment can be regarded as a drop, elongated to a length of as much as 1·2 mm. on a mammalian nerve fibre 20μ in diameter (Fig. 5). If a piece of rabbit's nerve is placed in hypotonic Ringer's solution (say 0·6 or 0·3 per cent) at 37° C. it soon becomes very turgid, and material is expelled from the ends to form mushroom-like outgrowths. Incidentally, as Ranvier pointed out in interpreting the effects of treating nerves with water, this provides further evidence that the contents of a nerve fibre are fluid and can move longitudinally. At the same time, the myelin shows remarkable movements, flowing over the surface of the axon, which it leaves bare for quite long stretches at the nodes (Fig. 6). Later the myelin may subdivide into shorter segments. These phenomena can be explained as follows. The swelling is mainly due to osmosis across the membranes at the surface of the axons, the latter increasing in volume. This produces a tendency to increase the area of the myelin, which rounds up under its surface tension, leaving the axon bare at the nodes.

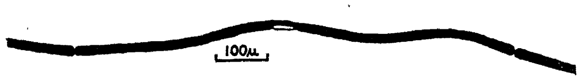


Fig. 5. NORMAL NERVE FIBRE, SHOWING A SINGLE INTERNODE WITH THE SCHWANN CELL NUCLEUS AT ITS CENTRE.

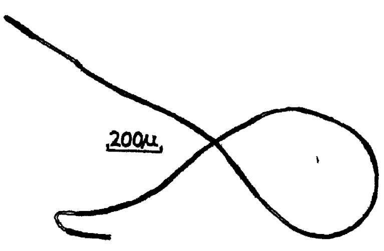


Fig. 6. FIBRE WHICH HAD BEEN FOR THREE HOURS IN DILUTED RINGER'S SOLUTION (0·3 PER CENT), SHOWING RETRACTION OF THE MYELIN AT THE NODES.

The experiment gives a clue to the factors controlling node-length during development. The myelin is laid down as the fibre is increasing in diameter, being first formed in the neighbourhood of the Schwann nuclei, which are spaced at more or less regular intervals along the fibre[10]. In the early stages, quite long regions of axon are left bare at the nodes. As the fibre grows in length and diameter the myelin continually tends to round up, as in the experiment with hypotonic solutions, and this prevents the individual segments from running together to make a continuous cylinder. By the time growth in length and diameter have ceased, the inturning of the neurilemma and the presence of a special 'cementing disc' (*c*, Fig. 1) at the node maintain the separation. During growth the segments of myelin increase in length but not in number. The first fibres to medullate are those which will ultimately become the largest, and these thus come to have the longest segments, whereas the smaller fibres, medullating later, have proportionately shorter and more numerous internodes. In confirmation of this hypothesis Mr. A. Vizoso, in this department, has recently found that after regeneration of an adult nerve for periods of more than a year, the internode-lengths remain short, even on the largest fibres. The internode-length is therefore not a function of diameter as such, but is determined by the relation between time of medullation and subsequent growth. Drs. F. K. Sanders and D. Whitteridge measured the conduction velocity of the nerves studied by Vizoso and found it similar to that of normal fibres of the same diameter, in spite of the short segments. Evidently conduction velocity does not have a close relationship to internode-length. Although the function of the nodes remains obscure, it may be that they serve to prevent movement of the fluid within the fibres. The aggregate of forces produced by the surface tension at the ends of a series of droplets is considerable.

Fibres of the central nervous system are usually without nodes, and lack the definite tubes which are present in peripheral nerve, no doubt to meet the stresses imposed by movement. In the absence of the tubes the myelin of the central fibres presumably wets the material which surrounds it, and therefore does not divide into segments. In confirmation of this is the fact that the central fibres rarely show incisures. They may develop an unduloid outline, but then proceed to break outwards, forming spheres and other figures at the crests of the waves.

There is obviously much to be done to confirm and extend this view of the nature of nerve fibres. The presence of the unduloid outlines and the forms seen during degeneration show quite decisively that the axon and myelin behave partly as liquids the surface tension of which affects their shape, and it seems likely that the intra-axonic pressure has an important influence on the stability of the fibre.


[1] Plateau, J., "Statique expérimentale et théorique des liquides soumis aux seules forces moléculaires" (Paris, 1873).
[2] Thompson, D'A. W., "On Growth and Form" (Cambridge, 1942).
[3] Darling, C. R., "Liquid Drops and Globules" (London, 1914).
[4] Young, J. Z., *Physiol. Rev.*, **22** (1942).
[5] Young, J. Z., *Nature*, **153**, 333 (1944).
[6] Weiss, P., *Anat. Rec.*, **88**, 464 (1944).
[7] Schmitt, F. O., Bear, R. S., and Palmer, K., *J. Cell. Comp. Physiol.*, **18**, 31 (1941).
[8] Glees, P., *J. Anat.*, **77**, 153 (1942).
[9] Ranvier, M. L., "Leçons sur l'histologie du système nerveux" (Paris, 1878).
[10] Speidel, C. C., *Amer. J. Anat.*, **52**, 1 (1933).


## ENGINEERING AND INDUSTRY IN RECONSTRUCTION

IN his inaugural address on October 12 to the Institution of Electrical Engineers, Sir Harry Railing made an assessment of the extent to which engineers, particularly those in the electrical industry, can and should contribute to the solution of some post-war problems. A broader understanding of sociological problems has become essential for the engineer, for the products of his technical skill affect every human individual and human organization. A greater understanding of science in general and engineering in particular has become essential for every citizen, not necessarily in the form of detailed knowledge, for a better comprehension of life. In the logical pursuit of his mission to help the post-war world, the engineer must therefore teach the principles which underlie his work, in the hope that they may be accepted and applied.

As to some of the more specific contributions which engineers can make towards solving international and

national post-war problems, we cannot envisage either an individual or an organization within a country, or a country within the community of nations, which will be able in future to maintain any monopoly in production, unless it can forge ahead in new developments and products, or can lead in quality or in production cost.

It is to-day more than ever essential that every individual in industry should be as highly developed and receive as good a general education and training in his handicraft or profession as possible, and that he should be taught a deep sense of personal and collective responsibility. This means not only education in engineering, but in team-work as well; and such education must stress the fact that anybody who accepts more from the team than he contributes, who seeks to take more out of life than he gives, constitutes a liability rather than an asset; on the other hand, every man who gives more than he receives creates values and therefore leaves something of positive value to his fellow workers at the end of his career.

Coming to the part played by industrial associations, it is now generally acknowledged that there is an ever-increasing volume of interests common to all members of a particular industry, the furtherance of which can be undertaken by such associations with great advantage both to the industry itself and to the market which it serves. Properly constituted associations have made great contributions to ordered industrial progress, and proved themselves a socially beneficial instrument through such activities as the standardization of specifications and common parts, the pooling and exchange of patents and manufacturing experience, a measure of joint research, the standardization of trading conditions, the collection of statistical information, the maintenance of good relations with other industries, and negotiations with Government departments and with labour.

So far as the position of industry within the State is concerned, we may start from two premises which to-day are generally accepted. The interests of the individual, of a group, of a class must all be subject to the proved interest of the community. With this reservation, however, a community will be most successful, advance furthest, and obtain the highest degree of development, if it allows the utmost freedom of thought, action and development to the individual and to groups of individuals. The action of any central authority should be not so much to instruct people what to do as to restrain them from actions which might be prejudicial to others.

Regarding the influence of wages, if wage-rates in a country increase more than the normal cost of living, there will generally be an increase in the volume of articles produced, owing to an increase in the effective demand. Also, with increasing wages, taken by themselves, the cost of the product increases, and therefore the quantity of goods which can be sold in the export market decreases; or alternatively, there is an increase in the cost of raw materials and food bought in exchange. There is, therefore, a wage limit which, for a country such as Great Britain, cannot be exceeded so long as other countries lag far behind its standard of living. It is consequently of vital concern to us to-day that the living conditions of less advanced countries, especially those which have become industrialized, should approach our own, and so bring about an expansion of world demand and the possibility for us to advance further, or at any rate to maintain our own standard.

The essentials needed to maintain the advance of British industry, therefore, are first of all, measures that assure the maintenance of any lead we can gain by increased research, better education, and the development of the more complicated and advanced problems; secondly, the provision of increased capital assistance for each worker, whether it takes the forms of increased power supply, tool equipment, transport facilities, improved lighting, or working conditions in general; and thirdly, the enlightenment and education of management and labour, and indeed of every worker, both as regards his own contribution and that of each partner with whom he must work; finally, any measures which help to increase the volume of our export business, and especially those which create expansion of world demand by raising the standard of living in backward countries.

## THE LISTER INSTITUTE OF PREVENTIVE MEDICINE

THE report for 1944 of the Governing Body of the Lister Institute of Preventive Medicine again records the wide scope of the work of members of its staff. The death of Prof. W. W. C. Topley has been a severe loss to the Council, and the Governing Body also lost the services of Sir Joseph Arkwright, who has retired after long service both in administration and research. Many of the staff remain in their war-time stations in laboratories in Cambridge, Oxford and elsewhere, and many of them are serving on committees set up by the Medical Research Council. Bacteriological and immunological researches in progress include work on the anti-proteus *OX* 19 serum for the treatment of louse-borne typhus, trials of which have been carried out in North Africa in co-operation with United States Army medical authorities. All the six severe cases treated with it recovered. The typing of typhoid, paratyphoid and food-poisoning bacilli with the *Vi* bacteriophage has been continued and a hitherto unknown *Vi*-phage type of the typhoid bacillus has been identified. The study of dysentery prophylaxis is making good progress and valuable work is being done on the immunology and nuclear structure of the gas gangrene organisms and on hyaluronidase. In collaboration with the Stormont Laboratory of the Ministry of Agriculture, Northern Ireland, outstanding contributions have been made to the study of trichomoniasis. Biochemical studies are in progress on specific blood-group substances, on the action of various bacterial toxins and on gramicidin, while work on low-temperature drying of biological materials and on fœtal and maternal serum is making good progress. The work on the large-scale processing of human serum and plasma for transfusion has produced valuable results. Problems arising in the kaolin processing of plasma have been solved and the Serum Unit has been filtering the entire output of the London blood transfusion depots before sending it on to Cambridge for freeze-drying.

Other work includes the cultivation of the virus of vaccinia, work on sex and other hormones and nutritional studies. The work done with the aid of volunteers at Sheffield has indicated how large are the vitamin A reserves of the liver of healthy human adults. Studies of the nutritive value of the potato have shown that potatoes are a rich source of vitamin

A and that, weight for weight, the nitrogen in potatoes has a biological value at least equal to that of whole wheat, although only about half of it is in the form of protein. It is believed that there is a supplementary action between the protein and non-protein nitrogenous substances in the tuber which is probably attributable to the amino-acids present among the latter, although the amides and basic nitrogenous compounds probably also take part.

When the nutritional state of housewives in Oxford and of women working in factories there was studied for a year, it was found that their nutritional state deteriorated very little, although that of the workers deteriorated more. There were no clinical signs of special nutritional defects, except that 25 per cent of the workers showed enlargement of the thyroid and 36 per cent of them had dental fluorosis: the incidence of both these conditions is high in north Oxfordshire.

The Institute continues to perform that valuable service, the maintenance of the National Collection of Type Cultures, for which more accommodation has been provided. Everyone will hope that very soon the staff of this Institute will be able to re-assemble in London and at Elstree to continue, in the closer collaboration made possible by that return home, the valuable work which is here so modestly reported.

G. LAPAGE.

# FORTHCOMING EVENTS

### Saturday, October 22

BRITISH RHEOLOGISTS' CLUB (at the University, Reading), at 2.30 p.m.—Annual General Meeting. Discussion on "The Measurement of Tack" (Introductory Papers by Dr. N. A. de Bruyne and Dr. R. F. Bowles).

QUEKETT MICROSCOPICAL SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. Nellie B. Eales: "Some Aspects of the Malaria Problem".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield, 1), at 2.30 p.m.—Mr. A. Preece: "The Oxidation of Steels in Furnace Atmospheres".

### Monday, October 23

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Engineer's Part in Certain Post-War Problems" (to be opened by the President).

### Tuesday, October 24

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Mr. J. E. Wright: "The Application of the Universal Decimal Classification to Telecommunication Literature—Some Suggestions for Developing the Tables to meet Modern Requirements"; Mr. L. S. Harley: "Document Classification in a Limited Field—Radiocommunication and Allied Subjects".

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Princes Gate, South Kensington, London, S.W.7), at 6 p.m.—Mr. C. F. Sayers: "Quartz Crystals and some of their Applications, with Specific Reference to Telecommunications".

ROYAL INSTITUTE OF CHEMISTRY (LEEDS AREA SECTION) (joint meeting with the LEEDS UNIVERSITY CHEMICAL SOCIETY) (in the Chemistry Lecture Theatre, The University, Leeds), at 6.30 p.m.—Prof. J. W. Cook, F.R.S.: "Some Chemical Aspects of Cancer Research".

### Tuesday, October 24—Wednesday, October 25

BRITISH SOCIETY OF ANIMAL PRODUCTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 10.30 a.m.—Discussion on "The British Sheep Industry".

**Tuesday, October 24**

Prof. R. G. White: General Survey; Mr. D. H. Dinsdale: "Hill Sheep"; Mr. T. L. Bywater: "Sheep for Long Leys"; Mr. J. F. H. Thomas: "Arable Sheep".

**Wednesday, October 25**

(Joint Meeting with the INSTITUTE FOR THE STUDY OF ANIMAL BEHAVIOUR). Mr. John Hammond, Jr., Mr. L. R. Wallace and Dr. Nancy Palmer: "Current Investigations relating to Sheep"; Dr. J. E. Nichols: "The Behaviour of Sheep Browsing under Drought Conditions"; Prof. Johnstone-Wallace: "The Grazing Habits of Beef Cattle"; Dr. K. L. Blaxter: "Food Preference and Food Habits in Dairy Cows".

### Wednesday, October 25

INSTITUTE OF FUEL (MIDLANDS SECTION) (at the James Watt Memorial Institute, Birmingham), at 2.30 p.m.—Mr. L. C. Southcott and Mr. D. W. Rudorff: "Superheaters for Water Tube Boilers" (Précis and Discussion).

SOCIETY OF CHEMICAL INDUSTRY (FOOD GROUP) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 3 p.m.—Mr. W. B. Adam and Mr. D. Dickinson: "Diagnostic Methods in Problems concerned with the Corrosion of Cans".

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (joint meeting with the PLASTICS GROUP OF THE SOCIETY OF CHEMICAL INDUSTRY) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. Willis Jackson and Mr. J. S. A. Forsyth: "The Development of Polythene as a High-Frequency Dielectric".

INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1), at 6 p.m.—Discussion on "Welding in British Industry after the War" (to be opened by Mr. H. I. Hodgson (Automobiles and General Engineering); Mr. C. S. Lillicrap (Shipbuilding); Mr. H. N. Pemberton (Pressure Vessels); Dr. H. Sutton (Aircraft)).

ROYAL INSTITUTE OF CHEMISTRY (DUBLIN SECTION) (at University College, Upper Merrion Street, Dublin), at 7.30 p.m.—Mr. H. G. Leonard and Mr. P. Whelan: "Spectrographic Analysis".

### Friday, October 27

INSTITUTION OF CHEMICAL ENGINEERS (CHEMICAL ENGINEERING GROUP) (at the Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1), at 3 p.m.—Sir Alexander Gibb, G.B.E., F.R.S.: "Hydro-Electric Development in Great Britain and its Influence on Chemical and Allied Industries" (Fifth Hinchley Memorial Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. Edward Reeve: "The Influence of Engineering on Social Advancement".

INSTITUTE OF FUEL (SCOTTISH SECTION) (at the Royal Technical College, Glasgow), at 5.45 p.m.—Mr. W. J. Skilling and Dr. M. McGregor: "Scottish Coal Resources".

### Sunday, October 29

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (joint meeting with the ASSOCIATION OF AUSTRIAN DOCTORS) (at the Austrian Centre, 69 Eton Avenue, Hampstead, London, N.W.3), at 11.30 a.m.—Dr. F. Bergel: "Life Saving and Life Preserving Plant Products".

# NATURE

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## CONTENTS



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# EDUCATION BEFORE DEMOBILIZATION

AMONG the limited number of benefits conferred on us by the War is the growth of the educational services in the Armed Forces. The work carried out has already been referred to in some detail in these columns[1]. The schemes have developed along different lines in the three Services, but in each case the amount and quality of work that is being done has reached proportions which would undoubtedly astonish those who were familiar with Service conditions in the War of 1914–18. In the Army, for example, a compulsory form of education has now been conducted for four years, and has grown into what must be one of the most searching and wide-ranging experiments in adult education that has yet been attempted. Soldiers and auxiliaries have been given opportunities of voluntarily studying subjects as far apart as chiropody and Chinese, music and metallurgy; the element of compulsion has been applied to the discussion of current problems and the way in which good citizens are produced. These miscellaneous activities have not been without effect, and it is not surprising, therefore, to find that Service education departments have been preparing even more comprehensive programmes for the release period which will begin when Germany is defeated. The Army and the Royal Air Force schemes were announced at the beginning of October, and it is expected that a statement will be made on behalf of the Royal Navy in the near future.

In the R.A.F., officers, airmen and airwomen, who have not been selected for regular service in the post-war period, are to be given a pre-release preliminary training to prepare them for return to civilian life, under a scheme which will be known as the Educational and Vocational Training Scheme. This will form part of the Government plan for the re-settlement of personnel after release from the service. The training will consist of three main types, re-settlement, educational and vocational, and will be part of an obligatory programme which will take up an average of six hours training time a week. Of these six hours, one will be devoted to re-settlement training, and run mainly on discussion-group lines and designed to give both background knowledge on post-war problems and information on the fundamentals of citizenship. The series of booklets, produced by the Army and called "The British Way and Purpose", will be used to deal with particular aspects of citizenship. To supplement the discussions, additional methods of instruction such as lectures, broadcasts, films, etc., will be used.

Educational training will be provided at secondary and higher levels and will allow R.A.F. personnel to improve both their general educational standards and their qualifications for civilian employment. At the secondary level, training will be devoted mainly towards the Forces Preliminary Examination. This Examination will be introduced to meet the needs of men and women who wish to prepare themselves for subsequent entry to certain universities, the Civil Service or some of the professions. Success in the

Examination will allow the candidate to be considered for entry to a university or to be exempted from the preliminary examination of the professional body concerned. It will in no way replace existing means of qualifying for entry to universities. Higher educational training will be available for those who have reached matriculation standard, and will normally consist of individual private study under the supervision of education officers and instructors.

Vocational training will be provided for civilian occupations only when the prospects of employment are favourable enough to merit training. Frequently, this training will consist of the conversion of a skilled R.A.F. tradesman into a tradesman fitted for a job in civilian life. In other cases, the aim will either be to improve existing civilian occupational qualifications or to give a man or woman with no qualifications the groundwork on which more specialized vocational training may be built outside the service. Since there is almost certain to be a great demand for training for jobs, it will scarcely be possible to provide resident specialist instructors at each station. Instead, pools of specialist instructors in technical and professional subjects will be maintained at some central station and will visit units to meet current requirements.

The training for vocations will be worked out in the following way: (1) There will be practical instruction and exercises on stations supervised by visiting instructors. (2) There will be courses in the basic theoretical subjects necessary for groups of civilian occupations. (3) Conversion courses will be arranged in station workshops. (4) When other facilities are not available, study syllabuses and text-books will be provided. (5) Close liaison will be maintained with civilian authorities, and attendance at classes in local technical colleges and schools will be encouraged.

The scheme announced by the War Office is less ambitious than that for the R.A.F. In a pamphlet called "Brush-up for Civvy St.", which has been issued by the Army Bureau of Current Affairs, the plan is modestly described as a means "for making up, so far as possible, those arrears of education and training which are a part of the debit side of war service", and the hope is entertained that the scheme will make an important contribution to the morale and community spirit of the Army during a difficult period.

The scheme itself is described in general terms in the pamphlet; the latter will be used immediately by regimental officers to acquaint their men with the main features. But these officers are categorically told that they must make it quite clear to the men that the educational scheme to be introduced in the release period is not intended to prepare them for a gilt-edged, guaranteed job. The business of getting soldiers into jobs, or getting them trained for jobs, will be mainly the duty of the Ministry of Labour. The Army itself can do no more than provide the men and women who are awaiting release with some kind of preliminary training which will be useful to them when they are demobilized. For those who need it, "it will teach the A.B.C. of industry and commerce, so that they can go out and learn the language". For the soldiers who do not require any preliminary vocational training, opportunities will be given to pursue hobbies and interests which will broaden their cultural horizon. Individuals whose professional studies have been interrupted by the War will be given a new chance to take up the threads by means of correspondence and other courses.

The varied principles of the scheme are described under eight headings. It will be compulsory, that is, it will be an obligatory part of the working time-table. This is merely an extension of the present system, but under the new regulations, educational training will be given more emphasis and more time. Variety will be introduced into the scheme in that the troops will have a reasonably wide choice in what they want to study. The third principle—that participation in the scheme as instructor or as one of the instructed will in no way affect the individual's chances of demobilization—will be one that will wreck the scheme at the outset unless it is said loudly and often. To fit in with military organization the new scheme will dovetail into the existing pattern of Army administration and procedure. Fifthly, the scheme will be co-educational and will apply equally to men and women whenever possible. For obvious reasons, it will not be possible to put the scheme into operation at any predetermined, fixed time; according to the pamphlet, "formations will 'lay on' the scheme at different times, depending on what part of the world they are in and what their other circumstances are (e.g. static, operational)". The close collaboration with the civilian educational bodies which already exists will be continued, partly for its direct and intrinsic value to Army education, and partly because, having had experience of what the civilian system can provide, soldiers may be more stimulated to use it after the War. Lastly, it is emphasized that the new scheme will be merely a growth of something that already exists; it will be the wider and better equipped development of educational schemes which have been operating in the Army since the winter of 1940.

Although the Army cannot provide a curriculum so diverse and selective as that of a polytechnic, the War Office has attempted to provide a broad classification of subjects of study within which all soldiers will find something near their requirements and interests. These have been grouped into six wide categories: (1) technology; (2) general science; (3) home, health and hobbies; (4) man and society; (5) commerce and the professions; and (6) arts and crafts.

Under the heading of technology, courses will be organized in electrical and mechanical engineering, building construction, and similar occupations. In general science, men and women will be given the opportunity to study essential scientific principles as applied to manufacture and the professions or the problems of industry and society. The third category is intended to meet many different needs; it is not meant to teach a wage-earning job, but will provide a background knowledge for the soldier who is interested in, say, gardening or poultry-keeping, or the auxiliary who wishes to know more about domestic

subjects. "Man and society" covers sociology in its wider sense while, under "commerce and the professions", courses will be arranged for men and women who wish to make a serious study of business organization or prepare to enter the Civil Service, local government or the professions. The sixth broad field, "arts and crafts", is intended for those who want to familiarize themselves with drawing or painting or musical appreciation. "Men and women who hope to go in for printing or design or architecture or teaching will all find something in this category to provide the first principles of their special need or interest."

The organization of the scheme shows how education in the 'Interim Army' will function in a way which has not previously been possible. Instead of the present system of two compulsory hours—Army Bureau of Current Affairs (A.B.C.A.) and British Way and Purpose (B.W.P.)—there will be six to eight hours a week of education. A.B.C.A. and B.W.P. will be retained as part of these and will be organized on a communal basis as at present, that is, on a platoon or squad or troop basis. For the other four to six hours, men and women will be treated individually and will join with like-minded individuals from any part of their unit to study the subjects they select.

The Army Educational Corps is to be considerably increased in numbers and will be responsible for the general direction of the scheme. But since the programme will be organized on a unit basis, the key men will undoubtedly be the unit education officers, "the 'amateurs', whose duty it will be to publicise the alternatives in the curriculum and to organise the facilities which unit resources can provide". They will be specially trained and equipped with manuals of guidance which should help them over some of their difficulties. The instructors will be selected from unit personnel and will be drawn from officers and other ranks. (The scheme as a whole will apply equally to all ranks.) A start has already been made in training instructors in a wide range of subjects at an Army school specially created for the purpose. Moreover, although the educational scheme for the release period cannot train men for jobs or find jobs for men, unit education officers will be supplied with a steady stream of information which will allow them to give "details of the various trades and professions and the qualifications required for them to those individuals who are in doubt about their careers".

Some of the educational activities will naturally be devoted to the passing of examinations; the Forces Preliminary Examination will apply to the Army in the same way as to the R.A.F. No doubt some unit education officers will be tempted to assess their achievement merely by the number of certificates their units can collect, but they will be strongly urged to keep this 'pot-hunting' in its proper place and concentrate their energies in giving a little to the lot rather than a lot to the few. No scheme of the above magnitude could be attempted without suitable accommodation and a considerable amount of equipment. It is heartening to know that already the premises in which educational work can best be conducted are being earmarked and scheduled for adaptation. Books by the million are also being negotiated for, as are the tools, the raw materials, the films, and other educational accessories.

In assessing the merits of the above scheme, it may be illuminating to recall a little of what happened when a former British Army was sent back to civilian life after a long war. As is well known, a comprehensive educational scheme for the Armistice period after the War of 1914–18 was drawn up by Lord Gorell and his staff. But since there had been no official recognition of education in the Army until September 1918, it can be understood that the scheme for the demobilization period had to be hastily devised and implemented. To the end of the scheme attendance remained voluntary. Further, the accommodation provided for the educational scheme was far from satisfactory in many cases, and often educational activities would have been impossible if the Young Men's Christian Association and the Church Army had not come forward to place their huts at the disposal of the service authorities. Much more unfortunate, the demobilization of men on a profession basis meant that all serving schoolmasters and students were demobilized almost simultaneously early in 1919, leaving the Army without a group of instructors that it could ill afford to lose.

In turning to the scheme proposed for the coming release period, one can see that it starts with many points in its favour. There is now a well-established Army Educational Corps the ranks of which have been considerably increased during the War. The war-time scheme has been in existence for four years already on an official basis, and had been in unofficial operation for some time before that. A measure of compulsion was introduced so far back as 1941. The early problems of accommodation were energetically tackled and in the interim period should present no difficulties incapable of solution. Above all, the way in which demobilization is to take place suggests that instructors and potential instructors will be demobilized in stages rather than as one group, leaving at least some behind who will close their ranks and carry on to the end.

Yet although there are many reasons why the present schemes announced by the Army and the R.A.F. should work, the fact remains that paper schemes, however brilliantly conceived, often fail to go beyond the infant phase. When the schemes are translated into practice, many obstacles will have to be overcome. Men and women who have become used to a life of movement and sometimes excitement will find it difficult to submit to the discipline of the class-room. If this is true of individuals who were previously accustomed to study, it will be ten times more applicable to those for whom regular study was hitherto unknown. The number of competent instructors is not likely to be nearly adequate. These, and other reasons, will present formidable problems. It will, indeed, be interesting to see whether the bolder scheme announced by the R.A.F. achieves more in the long run than the more cautious programme which the Army proposes adopting.

Nevertheless, although the Services are scarcely the ideal places for arranging educational programmes, these schemes should work—and must. The difficulties may be many; frustration and disillusionment will be inevitable. But Service educationists who have developed vast programmes during the War should not find the problem of expanding these schemes during the demobilization period beyond their skill and resource. If they need encouragement, they should be constantly reminded that their individual efforts will together make up one of the greatest contributions to democratic thinking yet attempted.

[1] *Nature*, 151, 440 (1943).

## PROBLEMS OF DEMOBILIZATION

### The Journey Home

A Report prepared by Mass-Observation for the Advertising Service Guild. ('Change' Wartime Surveys, No. 5.) Pp. 123. (London: John Murray, 1944.) 6*s*.

ALTHOUGH the Government has only just declared its demobilization plans, the question of demobilization has been ably discussed in reports from the political parties as well as in one of the usual admirable broadsheets from Political and Economic Planning. These, however, have been concerned essentially with proposals or principles for demobilization and to some extent this is true of Sir Ronald Davison's somewhat broader survey "Remobilization for Peace" in the "Target for To-morrow" series. Mass Observation, in its fifth major social survey since the War began, makes an attempt to chronicle what people are actually thinking about demobilization and to provide a sample of public opinion on this question for the guidance of those who have to plan "The Journey Home".

The report is admittedly qualitative in nature. Its main statistics are based on 570 interviews, half in London, and half in other parts of the country—in Manchester, Bolton, Newark, Bishop Auckland, and a cluster of Hampshire villages. This material was supplemented by reports from Mass Observation's National Panel of Voluntary Observers, while a series of smaller investigations were made to amplify and clarify trends emerging from the analysis of this material; and although the gross numbers are necessarily small, every effort was made to obtain a justly weighted cross-section.

The first point of interest that emerges from this survey is the soundness of the point made both in the *Planning* broadsheet and in the report of the Conservative Sub-Committee that the Government, having announced the general principles which it proposes to adopt, must see that they are strictly observed. Full publicity and strict observance appear to be even more important than the general details of the scheme, provided it is one which wins the approval and confidence of the members of the armed forces. Mass Observation drives home the point in reference to the points scheme outlined by the Conservative Sub-Committee itself, which, while embodying the type of principle which people appeared to consider a just and fair basis for priority in demobilization, made very little impression on the minds of the civilian population because propaganda was not continuous.

It must, of course, be remembered that sampling opinion by a series of questions in this way has the admitted defect of psychological laboratory tests that the test itself mostly creates an artificial situation which has somehow to be discounted. The questions are liable to start the questioned on an unaccustomed train of thought, at the end of which he finds his opinions are really not at all what he supposed them to be. For all that, a study of the report suggests that the summary does give a composite picture of the hopes and fears of the Englishman or Englishwoman at the time of the inquiry, even if the spontaneity or representative character of particular sets of answers is to be discounted.

The picture, it is true, is largely one that might have been expected. Nevertheless, it throws some light on the conflict in the public mind between ideas of liberty and fairness, between conceptions of democracy and efficiency, and in this respect "The Journey Home" is of interest in relation to the question of other post-war controls than those involved in demobilization. The conclusion that no executive action will be a success unless the hopes, fears, moods and expectations of the masses who will be affected are taken into consideration has a wide bearing on post-war planning. To the extent that tension between expectation, hope and realization leads to a sense of frustration becoming prominent, the possibility of a harmonious solution of demobilization or other social problems recedes.

Clarification of ideas on demobilization is the first step, it is urged by Mass Observation, though "The Journey Home" cannot be regarded as a contribution to that end comparable with Sir Ronald Davison's little book. "People need to know more than how and when they are coming out. They need to know where they are going then. They need to know where everyone is going, what is going to happen to mankind." There is a task, or rather a duty, of exposition or interpretation which is primarily the responsibility of the Government, whether through the Ministry of Information or in some other way, and a popular booklet at a much lower price than "Remobilization for Peace" would be valuable.

But beyond this it might be added that the success of demobilization and of post-war reconstruction depends on people minding enough about the future of mankind to accept responsibility for concrete action themselves. There is nothing in this survey that indicates more clearly the weakness of democracy than the tendency of those interviewed to dissociate themselves from their democratic responsibility by saying 'they' instead of 'we' when they mean the powers that be. The report is a timely reminder of how much yet remains to be done in this direction and how much a democratic system depends on an educated electorate. To the sociologist it is of interest as an example of technique in the analysis of public opinion on any subject, and incidentally raises the fundamental question of what we understand by public opinion. It has, however, a wider appeal to all who are concerned with the prospects and possibilities of post-war planning as indicating not merely some of the dangers and difficulties to be faced, the immensity of the task of education, but also practical problems for each individual, of adapting and fitting his own hopes and aspirations into those of the community as a whole if demobilization is to prove what it is intended to be—the first step towards remobilization for peace, for building up the future of man.

R. BRIGHTMAN.

# DIAGNOSIS AND TREATMENT OF VENEREAL DISEASES

## The Venereal Diseases

A Manual for Practitioners and Students. By Major James Marshall. Pp. xi+348. (London: Macmillan and Co., Ltd., 1944.) 21*s.* net.

IT is both unfortunate and remarkable that the average general practitioner knows so little about venereal disease; unfortunate because it seems not unlikely that he will have to treat much of it in the near future, and remarkable because ignorance of it is all too common. Marshall's "Venereal Diseases" contains just that practical information which the student and the practitioner require, set out clearly and succinctly. No one within the compass of 340 pages can say all there is to be said about venereal disease, but this book does contain the salient facts; almost everything that is excluded is essentially a matter for the expert. Gonorrhœa—the commonest venereal disease—is allotted some ninety-odd pages, into which is crammed a vast amount of information. The anatomy of the urogenital system, without a knowledge of which treatment must be largely empirical, is clearly explained, the importance of pathological examinations in diagnosis rightly stressed, and treatment, especially with sulphonamides, skilfully handled. Case-records indicate how different types of cases should be treated, and any problems not covered by this section should be referred to a specialist. A word of warning concerning the use of sulphonamides in patients previously treated with these drugs, and the possibility of sensitization, might have been included with advantage.

Syphilis is condensed into less than 280 pages—an impossible task if the whole subject is to be covered in detail; for this reason the rarer conditions have been excluded or only touched on briefly, most attention being given to the commoner aspects. The coloured plates, of which there are eight, are for the most part beautifully produced, and represent the nearest approach to real life which the photographer's art can provide. Numerous figures show clearly a variety of morbid conditions, and should prove most helpful to the reader. Stress is, very rightly, laid on the importance of pathological aids to diagnosis; to diagnose early syphilis without these is nothing short of criminal. Treatment of late syphilis must be individualized, and most cases should be referred to experts; that of early syphilis can, however, be more or less stereotyped. That recommended is the 'continuous' with overlapping arsenic and bismuth; many will think the dosage rather heavy in the early phases; but there can be no shadow of doubt that over-treatment is far preferable to under-treatment, and the latter is all too common. The therapist is given the choice of neo-arsphenamine, 'Mapharside' and 'Neohalarsine'; the first-named is the most popular in Great Britain; 'Mapharside' is being used more and more; 'Neohalarsine' is still on trial. The routine bismuth preparation recommended is the aqueous suspension of the metal.

The section on the side effects of arsenicals is particularly good and very important; that of post-arsphenamine jaundice is outstanding, the author being an acknowledged authority on the subject. Arsenical drugs are notoriously dangerous, and everyone who undertakes the treatment of syphilis should know how to handle them. The section on "Other Venereal and Allied Diseases" contains a short account of those conditions likely to be met with in general practice which are venereal or associated with venereal disease. Not everyone realizes the ubiquity of *Trichomonas vaginalis*, nor the fact that scabies is often acquired during sexual intercourse. Warts or condylomata acuminata are often difficult to eradicate, and frequently considerable ingenuity is required to cure a non-specific urethritis; if the directions given are followed, few failures will be recorded.

Practical instructions in irrigation, urethroscopy, dark-ground examination, the giving of intravenous and intramuscular injections, lumbar puncture, fever therapy and prophylaxis, add very considerably to the value of the book, while the appendix on the "Sociology of Venereal Diseases" should be very carefully studied by all who are interested in these diseases as a public health problem; simply to treat the patient with drugs is not the only duty of the practitioner; for every patient with venereal disease who consults a doctor there is always another—often several—who may not even know they have the disease.

It would seem almost churlish to criticize such an excellent book, but criticism may be permissible if it is constructive and perhaps helpful in the preparation of future editions. While the meaning almost everywhere is clear, the English is sometimes loose and the grammar frequently bad; there are plural nouns followed by singular verbs; a vaginal discharge is not a symptom but a sign. "A course of 10 injections is given every other day" will not stand analysis; bi-weekly is a term to be avoided since it can mean twice a week or once in two weeks; instrument is usually a substantive, not a verb; such expressions as "results as good, if not better, than", "Fibrosis which replaces the elastic tissue", "being satisfied that there is no evidence of syphilis . . . a detailed examination of the genitals is made" are not good English and offend the reader.

Some reference to the use of alkalis in combination with the sulphonamides, more use of oil-soluble bismuth, a description of the Dattner lumbar puncture needle, and more information concerning the treatment of non-specific urethritis, would be valuable additions. Nevertheless, there can be no doubt that this book will have a wide circulation, and deservedly so.

# FLOOD CALCULATIONS

## Flood Estimation and Control

By B. D. Richards. Pp. vii+152. (London: Chapman and Hall, Ltd., 1944.) 16*s.* net.

IN this book the author deals with the problem of estimating the maximum flow which may be run off a catchment area during a period of exceptional rainfall. Provision to deal with such maximum flows has to be made in many civil engineering works. In the construction of a reservoir, for example, means must be provided to ensure that when the reservoir is full, all surplus water will be carried off in such a way that the stability of the embankment or dam is in no way affected. Bridges over rivers or streams must have large enough waterways to allow the maximum flood water to flow under the bridge without injuring the structure. Culverts carrying water-courses under roadways or railways must be so

designed that the greatest flow likely to happen may be conveyed without damage to the constructed works. The problem of the engineer is to estimate the probable amount of flood water and to make provision accordingly.

The subject of flood prediction is not new. The author himself points out that it has long been one of the perennial problems of civil engineering. The estimation of such floods is difficult. While, as the author states, floods follow natural laws, the number and complexity of the factors and the interplay between them make precise estimation impossible.

In his foreword, Mr. Binnie regrets that the records of floods which have occurred in the past in the British Isles are limited, and that we are so far behind other countries in taking steps to ensure that such information is available. According to the author, however, a flood of exceptional severity may possibly be met with once only in a hundred years. Complete security can only be obtained, he adds, by ascertaining the maximum possible flood and making due provision accordingly. In connexion with this it may not be out of place to point out that, however meagre the information has been in the past, the civil engineering structures in Britain likely to have been affected by floods seem to have been remarkably well designed to meet such emergencies. The number of reservoir dam disasters in the country in the past century can be counted almost on the digits of one hand. There are bridges over rivers and streams which are centuries old and which have stood the test of time and flood. On the other hand, the number of dam disasters alone, in the United States, run into hundreds. But in America, as on the continents of Europe and Asia, catastrophic floods occur far exceeding anything ever experienced in Great Britain. In whatever country floods occur, the engineer must take into account their possible magnitude, and his designs must be such that they are safe in any circumstances.

The author begins by discussing generally the factors affecting the intensity, duration and discharge of floods. These factors depend upon the rainfall and size and characteristics of the area on which the rain falls. The number of formulæ which have been deduced by previous investigators is impressive. There are no fewer than ten of these given and they do not include all. One of those omitted is the Iszkowski formula so widely accepted in Germany and Austria. The ten given are sufficient, however, to show widely divergent results obtained by the different formulæ when applied to a single rainfall on a given catchment. Most of these do not take into account the shape and contour of the ground. It is the purpose of this book to show how a more accurate estimate of the flood discharge may be made.

Very properly the first point dealt with is rainfall intensity. Rainfall both as a function of time and as a function of area is discussed. Examples of curves as well as actual recordings of intense rainfalls are given, not only for the British Isles but also for Central India, the eastern United States, Southern Rhodesia and Western Australia. Then follows a discussion on the period of concentration intensity and run-off of the flood. There are some interesting graphs showing how coefficients vary on larger and smaller areas when compared with a standard catchment of 25 square miles. The coefficients for flood estimation, taking all the factors—including the size and slope of the catchment—into account, are next dealt with, and then follows the determination of maximum flood discharges by the construction of flood hydrographs. The chapter dealing with the effect of intensity and distribution of the rainfall on the flood hydrograph will be found rather difficult reading by most engineers; but an excellent summary of all that has been written follows. A chapter on flood control as applied to reservoirs deals with open weirs, siphon spillways and under-sluices combined with overflow weirs. The chapter dealing with soil erosion should be of special interest to irrigation engineers Finally, there are some useful examples of flood calculations.

The book will be found of great value to all engineers who have flood problems to deal with. Hitherto the designer of structures which have to withstand the effects of floods has had to rely on empirical formulæ giving widely varying results. He may now, by applying the principles set forth in this volume, arrive at a much more reliable result in determining the maximum flood discharge.

The task of writing such a book as this is obviously an enormous one, and the author is to be commended very strongly on the results which he has achieved.

JOHN BOWMAN.

## SYNTHETIC RUBBER

### Modern Synthetic Rubbers

By Dr. Harry Barron. Second edition, revised and enlarged. Pp. xii+355+20 plates. (London: Chapman and Hall, Ltd., 1943.) 28*s*. net.

IN view of the large amount of material published, especially in the American technical Press, in the last two years on synthetic rubbers, we should expect the second edition of Dr. Barron's book to be a big improvement on the first edition, and such is the case. The general lay-out remains excellent and the contents make interesting reading from cover to cover. It is written in a most readable form and the plates are excellently reproduced. The scope of the second edition is roughly the same as that of the first—economics, chemical and physical background, and technology—but it has been considerably amplified in detail. The first edition has been carefully revised, but a few mistakes such as (p. 29) *GR–N* instead of *GR–M* for Government neoprene have crept into the new edition.

From the point of view of the general reader, there are only two criticisms to offer against this new edition; and they are that the author sets out so obviously to be the champion of synthetic rubber that his views cannot be accepted as unbiased on this important controversy of natural versus synthetic rubber. On p. 177 the statement is made that "the largest and most critical users of rubber, the major American tyre companies, have investigated Buna *S* [it is assumed that Buna *S* is here meant to be *GR–S*] in tyre treads and the general conclusion is in favour of Buna *S* against natural rubber". It is doubtful, in the opinion of the reviewer, whether any tyre manufacturer could be found who would use Buna *S* (or *GR–S*) if alternative supplies of natural rubber were freely available. Other examples of this same attitude could be quoted; for example, on p. 25 the variation (variability) of natural rubber is discussed and the suggestion is made that it does not or *should not* occur in synthetic rubber in the following words: "in fact, the latter [the synthetic

rubber interests] are perhaps more favourably placed since, working from pure materials, they can produce a material of definite properties and characteristics. Synthetic rubbers can virtually be made to specification". Unfortunately, the synthetic rubber interests do not work with pure material—it would be impracticable—and do not produce invariable material; in fact, the variations in synthetic rubbers are as big, if not bigger, than those in natural rubber. In further elaboration of the purity question, the author states on p. 84 that the butadiene for *GR–S* must be 98·5 per cent pure, but it is probable that much *GR–S* has been made from butadiene of as low purity as 95 per cent. When it is kept in view that different processes for butadiene will give different impurities and these impurities may enter into or direct molecular structure in different ways, it is not surprising that the resulting products have been variable to some extent. Experience has shown that chemical control, however detailed, in the shaping of large molecules is a poor substitute for the vital control of Nature.

The second criticism is one which also applied to the first edition, namely, that the author, in spite of his anxiety to see more work carried out on this side of the Atlantic, does not appear to realize how much fundamental work has been carried out in the last few years in Great Britain; for example, on p. 80 no mention is made of the fact that the pioneer work on the production of butadiene from 2·3 butylene glycol diacetate was carried out in Manchester, or on p. 221 that the first copolymers of butadiene and substituted acrylic acids were prepared and evaluated in the same city. Many other British contributions have also been overlooked.

From the point of view of the technical reader, there is a further criticism. The phraseology is sometimes rather unorthodox; for example, on p. 220 there appears the sentence: "While butadiene is the main constituent, there are various synthetic resins, other than styrene and acrylic nitrile which have been successfully developed as copolymer". Synthetic resins are not monomers and styrene and acrylic nitrile are not synthetic resins. The sentence is, in fact, a sort of technical double negative.

In spite of its defects the book is to be recommended to those who wish to acquire a general knowledge of the field of synthetic rubber. W. J. S. NAUNTON.

## ENZYME CHEMISTRY

Chemistry and Methods of Enzymes

By Prof. James B. Sumner and G. Fred Somers. Pp. xi+365. (New York: Academic Press, Inc., 1943.) 5 dollars.

A BOOK on enzymes by the hand of Dr. Sumner might well be expected to present an authoritative review of that phase of enzyme work with which his name is intimately associated, namely, the preparation and properties of crystalline enzymes. In this we are not disappointed. The accounts of the preparations of urease and catalase, of the work of Northrop and Kunitz on the preparation of crystalline trypsin and chymotrypsin, of Anson on crystalline carboxypeptidase, leave little to be desired in an introductory book of this nature. When we turn, however, to the consideration of the larger aspects of enzyme chemistry, Sumner and Somers' book can only be regarded as consisting for the most part of descriptions of the preparations and characteristic properties of a fairly extensive list of enzymes. The distinguishing feature of this compilation is the treatment of each enzyme by short statements under a number of headings such as history, occurrence, action, specificity, etc. The statements tend to be very brief, with a consequent curtailment of any critical discussion of the properties of enzymes and of recent work bearing upon their mechanism of action. The authors state, however, that they have attempted to give the research worker and advanced student a general survey of enzyme chemistry without presenting too much detail on any subject, and in this objective they may be said to have succeeded—perhaps only too well.

The book commences with a chapter on the general properties of enzymes. This deals mostly with the physical chemistry of enzymes. The treatment, in common with that of the rest of the book, is sketchy and terse, lacking the details and explanatory data necessary to make the somewhat complicated subject of enzyme kinetics clearly intelligible to the student. The chapter deals briefly with most matters proper to a physicochemical description of enzymes and includes short statements concerning activators, protective substances, poisons, coenzymes and anti-enzymes.

The remaining seventeen chapters of the book are concerned with a fairly comprehensive survey of enzyme systems. These are classified into the hydrolytic group comprising the esterases, carbohydrases, phosphorylases, nucleases, amidases, and proteolytic enzymes; the oxidizing group comprising those enzymes possessing iron-containing constituents, and those depending for their activities on the presence of copper, the various dehydrogenases and flavin-containing enzymes, and a batch of oxidizing enzymes which apparently defy adequate classification; and finally the desmolases.

The final part of the book consists of two chapters, the first of which is devoted to a brief description of hydrases and mutases, and the second to a description of some mechanisms involved in carbohydrate metabolism as illustrative of the manner in which enzyme reactions in the living cell are brought together.

Omissions of greater or lesser importance must obviously be characteristic of a book which aims at curtailment of detail. Sumner and Somers' book suffers from the omission of many facts concerning enzyme chemistry of equal interest to those actually presented. Thus, to give a few examples, nothing is said of the ability of lactic dehydrogenase to reduce alloxan in the absence of a coenzyme, a fact pertinent to any discussion of the mechanism of action of the coenzyme-linked dehydrogenases. Nothing is said of the inhibitive action of oxalacetic acid on the activity of succinic dehydrogenase and of the importance of thiol groupings in the make-up of this enzyme. There is but little mention of the reversible poisoning of enzymes by dyestuffs, of the effects of narcotics on respiratory enzyme systems, or of the general principles of competitive inhibition of enzymes so important to-day in the interpretation of many facts of therapeutic and pharmacological significance.

In spite of these shortcomings, Sumner and Somers' book will undoubtedly prove to be of much interest to the student of enzyme chemistry, and it is a welcome addition to the steadily increasing number of text-books on the subject. J. H. QUASTEL.

# COLONIES OF *PENICILLIUM NOTATUM* AND OTHER MOULDS AS MODELS FOR THE STUDY OF POPULATION GENETICS

By Dr. G. PONTECORVO
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AND
Dr. A. R. GEMMELL
Department of Botany, University of Glasgow

EXPOSURE of mould colonies to X-rays has long been known to give rise to 'sectorial' mutants. Mutant 'sectors', of course, also arise 'spontaneously' in Fungi as well as in Bacteria. The frequency varies between strains, but is always much smaller than the maximum obtainable by irradiation. *Penicillium notatum* is no exception, as we have obtained mutant 'sectors' in abundance following irradiation, and occasionally without irradiation. All 'sectors' isolated gave rise to mutant strains, differing from the original in morphological or metabolic properties.

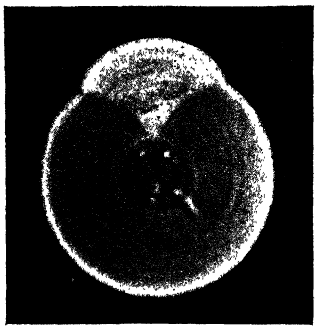

Fig. 1. 'SPONTANEOUS SECTOR' OF *Penicillium notatum.*

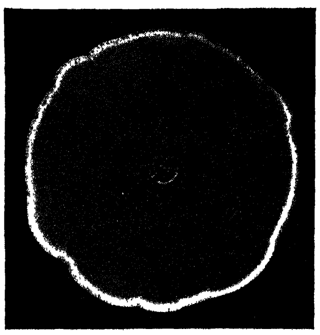

Fig. 2. IRRADIATED COLONY SHOWING MUTANT 'SECTORS' OF DIFFERENT SHAPES.

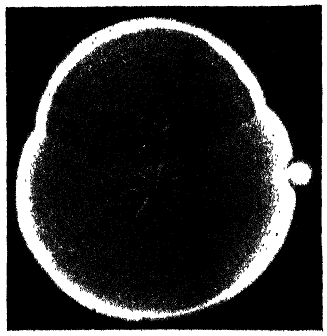

Fig. 3. TWO SEPARATE COLONIES WITH DIFFERENT GROWTH-RATES MEET AND COMPETE FOR THE SAME TERRITORY.

The analogy between 'sectoring' in Fungi and somatic mutation, or segregation, in Metazoa and Metaphyta is evident. But the two-dimensional type of growth of mould colonies makes them an unparalleled material for following the fate of a single mutated cell in a growing population of cells. Natural selection and chance can be seen here at work, under measurable conditions, and leave, as it were, a graphical record of their effects.

It is surprising indeed that so little attention has been paid to the strikingly regular shapes of sectors, both 'spontaneous' (Fig. 1) and induced (Fig. 2), and to the significance of these shapes. Even though the term 'sector' is a geometrical misnomer, since the majority have curved borders or open out at too great an angle, most 'sectors' lend themselves to description in very simple geometrical terms. They may be classified into three elementary types and combinations of them. Fig. 3, *a, b, c* show diagrammatically these three simple types, and Fig. 3, *d*, one of the complex types, a combination of *c* and *a*. Whereas 'sectors' induced by irradiation may show any one of the three elementary shapes and of their possible combinations, 'spontaneous sectors' in Fungi and Bacteria are almost exclusively of type *a*. It will be noticed (Fig. 3) that X-ray induced sectors have their origin where the edge of the colony was at the time of irradiation. This is simply because the increase in diameter of a colony takes place by multiplication of cells in or near the hyphal tips that form its edge. A nucleus has, thus, a chance to give rise to a patch of mutated mycelium only if it was situated on the growing fringe of the colony at the moment it underwent mutation. But it will also be noticed that whereas 'sectors' of type *a* taper towards the irradiated edge from which they originate, types *b* and *c* originate in a sort of blunt apex. We shall see why later.

Before discussing the geometry of 'sectors', let us consider the mode of growth of a mould colony under certain conditions (hard agar and others) which are essential for obtaining regular shapes. Under these conditions, growth of colonies is, as a first approximation, two-dimensional. A hyphal tip or a germinating spore free from competition branches in all directions in a plane so rapidly that it soon forms a circular microcolony; from this moment the colony grows as a circle, expanding in diameter at a uniform rate so long as there is further medium to occupy. The hyphæ elongate radially, with little intertwining, and branch to fill the increasing space available. The circular expansion of a colony made up of homogeneous mycelium is the resultant of the potentially circular expansion of each one of its myriads of hyphal tips, limited by the fact that the territory occupied by one hypha cannot be occupied by another. Hence (1) if a hyphal tip in a large colony were set free from the competition of its neighbours, it would soon produce a roughly semi-circular microcolony bulging out from, and with centre upon, the edge of the larger colony; (2) competition between hyphæ is extremely severe, and consequently natural selection has plenty of scope for operating.

Let us now suppose that in such a homogeneous colony a hyphal tip suddenly changes its growth-rate. If the new growth-rate is lower, usually the mutated hypha will soon be surrounded by branches of its neighbours and prevented from further growth. No trace of the event will be visible. If the new growth-rate is higher, on the other hand, usually the result will be a 'sector' of type *a* (Fig. 3, *a*), the boundaries of which are parts of equiangular spirals, with characteristics depending on the ratio of the two growth-rates and the diameter of the mother colony when the changed system arises. A verification of this geometrical explanation can be made by deliberately imitating natural sectors. If a small inoculum is made with a suspension of spores of two strains having different growth-rates, and the spores of slower growth form a big majority, the results are indistinguishable from 'sectors' of type *a*

(Fig. 4). It seems that a mutation endowing a hyphal tip with a higher growth-rate is all that is needed to explain the shape of 'spontaneous' and X-ray induced 'sectors' of this type.

The shape of 'sectors' of type *b* seems, at first, rather mysterious. The straight sides proclaim them to have a growth-rate equal to that of the mother colony. But with an equal growth-rate a hyphal tip should not be able to produce a 'sector' other than one with vertex at the centre. 'Sectors' of this kind do occur after irradiation, but not frequently. Most type *b* 'sectors' have vertex away from the centre. Again, the imitation of 'sectors' by mixed inocula has given a clue to a possible mechanism. If a small inoculum is made with a thick suspension of spores of two strains with equal growth-rates, the result is a colony made up of nearly radial sectors of one strain alternating with similar sectors of the other, a sort of rising sun figure (Fig. 5). If, however, the inoculum is large, irregular in shape and contains few spores, some of the sectors open out at great angles. Obviously some initial positional advantage plays a part. The next step is to control this positional advantage by starting two colonies, one of each strain, at different times and near each other (Fig. 6). The results are as those given by the intersection of two systems of concentric circles, expanding at the same rate, but differing in diameter when they first meet. The intersections are hyperbolæ and the angle between the asymptotes depends only on the ratio of the two diameters when the systems first meet (Fig. 3, *e*). The smaller the diameter of the small colony (or system) in relation to that of the larger one, the smaller becomes this angle and the more nearly do the sides of the resulting 'sector' coincide with the asymptotes and look like straight lines forming a blunt vertex. To explain 'sectors' of type *b*, to which many of those produced by irradiation belong, we have thus only to assume that the mutated hypha either had, immediately after irradiation, a positional advantage over neighbouring hyphæ, or that it enjoyed for a short time a much higher growth-rate. Plausible mechanisms of either type are easily imagined. For example, irradiation may kill a high proportion of hyphal tips and the surviving ones have a greater *Lebensraum*. Alternatively, differences in metabolism between mutated and non-mutated hyphæ may give one of the former a temporary advantage depending on conditions of the medium temporarily altered by irradiation.

'Sectors' of type *c* are nothing more than a modification of the preceding case; that is, the mutant has an initial temporary advantage, but a growth-rate lower than that of the mother colony. The experimental imitation of 'sectors' of this type needs no comment (Fig. 7).

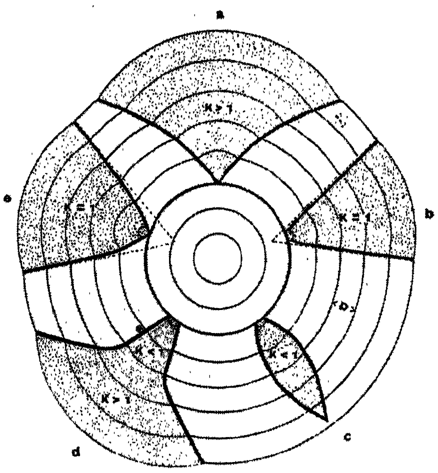

Fig. 3. GEOMETRY OF 'SECTORS': *a*, *b*, *c*, THE THREE SIMPLE TYPES, *d*, ONE OF THE COMPLEX TYPES, *e*, 'SECTOR' OF TYPE *b* IMITATED BY STARTING TWO COLONIES WITH EQUAL GROWTH-RATES AT DIFFERENT TIMES. HEAVY CIRCLE INDICATES EDGE OF COLONY WHEN IRRADIATED. *K*, RATIO OF GROWTH-RATES OF SECTOR AND COLONY; *D*, INCREASE IN RADIUS PER UNIT TIME.

The types of 'sectors' so far discussed are those in which mother colony and mutant have growth-rates bearing a fixed ratio to each other over a long period. A number of sectors with shapes interpretable as combinations of those so far described, however, are obviously not of this type. The ratio changes as the colony grows old. This may be due to a special growth habit of the mutant, that is, something detectable even if the mutant is grown by itself, or it may be due to an interaction between mutant and mother colony. Among the mutants we have isolated both types are represented. A simple example of non-reciprocal interaction is that of a mutant which grows more slowly than the normal strain on acid medium and more quickly on alkaline medium. As the *p*H of the medium changes (from acid to alkaline) with the growth of a colony, so also does the intersection curve between normal and mutant colonies grown side by side; its final form depends on the time of inoculation of the mutant after the establishment of the normal colony. If very soon (acid medium), the mutant will form a type *c* 'sector'; if somewhat later (acid medium changing to alkaline), the mutant will form a type *d* 'sector'; if still later, the mutant will expand at the expense of the normal.

Cases of reciprocal interaction, namely, antagonism or collaboration, between two or more strains are identifiable and analysable by some such methods. Another problem, in addition, can be investigated along these lines: that of changes in the medium,

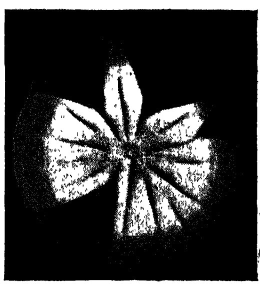
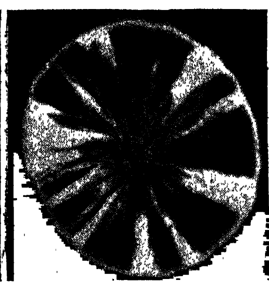
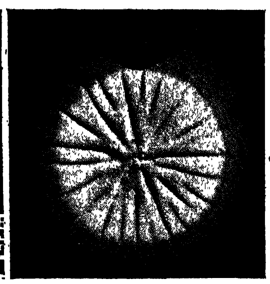
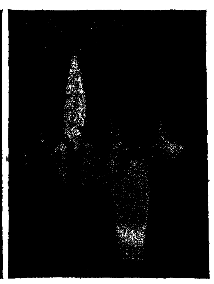

Fig. 4. Fig. 5. Fig. 6. Fig. 7.

Figs. 4–7. IMITATION OF VARIOUS TYPES OF 'SECTORS' BY INOCULA OF TWO STRAINS WITH EQUAL (FIGS. 5, 6) AND DIFFERENT (FIGS. 4, 7) GROWTH-RATES. FIG. 5 GIVES A GRAPHIC MODEL OF THE SEWALL WRIGHT EFFECT.

produced by the growth of a colony, which put a premium on mutants more fit than the mother colony for growth in the changed medium. This problem is that of formation of secondary colonies, which is familiar to bacteriologists.

Between the occurrence of a 'visible' mutation and the establishment of an actually visible patch of mutated mycelium there is a long way to go. In the initial stages, before the mutant has succeeded in securing a 'bridgehead', its survival or extinction is almost entirely a matter of chance. Once the bridgehead is secured, the systematic advantage or disadvantage of the mutant with respect to the parental strain determines the characteristics of the surfaces occupied by each, and therefore the ultimate fate of the mutant. Figs. 1, 4, 8 are examples of the simplest case, that of two strains one of which, with a higher growth-rate than the other, will ultimately supplant it. With certain obvious restrictions, these are models of the spread of a favourable gene in a population under the stress of natural selection alone. In Fig. 1 the mutant starts as a single individual in a large population; in Fig. 4 the mutant starts as 10 per cent of the initial population; in Fig. 8 two separate populations with different growth-rates start at the same time and compete for the same territory: the boundary between them is a circle.

It is, however, as models of the accidental multiplication or elimination of genes, and its dependence on the size of the population, that mutants of moulds can be most useful. Mixed colonies of strains with equal growth-rates are especially instructive, since in them the effect of natural selection between strains is nil, and that of chance alone stands out. A colony of this type, begun with great numbers of spores of each of two strains, shows (Fig. 5) in its early stages an apparently thorough mixture of both. Later on, the colony becomes made up of clearly distinct sectors each of either one or the other strain. As, with appropriate magnification, the early apparent mixture is seen to result from an alternation of very thin radial strips of each strain, the difference between earlier and later structure is simply a substitution of fewer sectors of great width for an initial very large number of sectors of very small width. Clearly a process of sorting out takes place: sectors which are too small in width either increase in width or disappear. The result is that any small apparently mixed arc in the young colony gives rise, after sufficient growth, to an arc in which one strain only is established to the exclusion of the other.

Here is an evident analogy with the Sewall Wright effect of the small size of populations upon the accidental fixation or extinction of genes. In the case of sexually reproducing species, the effect is due to the sampling nature of the reproductive process: accidental fluctuations in the frequency of a gene may, in a small population, reach the irreversible alternatives of either fixation or loss. In mould colonies a similar sampling operates. A hyphal tip in a colony of radius $r$ gives rise, *on the average*, to $r'/r$ hyphal tips when the colony has grown to radius $r'$. Accidents of growth, however, allow for fluctuations around this average: one hyphal tip will contribute more to the next 'generation', and another one less and leave no 'progeny'. In a small arc, with a small number of hyphal tips of two strains alternating, these fluctuations will be reversible and preserve the mixed constitution of the arc, so long as they do not happen to reach the irreversible state of all hyphæ being of one or the other strain. This will ultimately bring about the segregation of the two strains into 'sectors' of substantial size. To grasp fully the analogy between the Sewall Wright effect in sexually reproducing organisms and our example, one has to substitute a hyphal tip for a gene, and a small arc of the colony for a small population.

There are several possible ways of measuring the intensity of the sampling effects in moulds: unlike the sampling effect of sexual reproduction, its variance may be expected to depend on external conditions.

In conclusion, the remarkable diagrams that mould colonies may be made to produce offer a range of opportunities for the experimental approach to problems as apparently unrelated as morphogenesis and genetics of populations.

We wish to thank Miss A. H. Waddell for advice on the mathematical side, and Dr. W. M'Farlane, who carried out the irradiations at the Western Infirmary, Glasgow, for his most helpful contribution to our discussions. A research grant from the Carnegie Trust for the Universities of Scotland has covered part of the cost of materials.

# FOUNDATIONS OF ELECTRICAL MEASUREMENT*

By Dr. L. HARTSHORN
National Physical Laboratory

THE last two or three years have seen the publication of a surprising number of papers on the fundamental magnitudes of classical physics. Even more surprising is the divergence of opinion expressed on such well-worn themes as the precise significance of the magnitudes of everyday electricity and magnetism. Well-known expounders of these subjects at our universities have found one another unintelligible, and practising engineers and physicists have frequently been heard to ask if these concepts are really as doubtful as all that after half a century of experience and discussion.

There seems to be fairly general agreement that the working concepts should be defined by reference to the processes by means of which they are measured, but there is no sort of agreement as to what these processes are. It appears that there are many possible processes for each quantity and no agreement as to their relative status. One of the troubles is that the processes described are usually idealized. They have been described as 'theoretical experiments'. It is agreed that they have not actually been performed, but it is asserted that they could be performed in principle; for example, you take two point charges and measure certain distances and forces and so on, operations which appear to the experimentalist of to-day as practically impossible, and in the results of which he would have no confidence whatever.

An outstanding fact, and one which the experimentalist finds very reassuring, is that all the doubt and discussion surrounding these theoretical experiments seem to produce no repercussions on his own real experiments. His values are usually accepted without argument, understood and acted upon with useful results. He can only conclude that these theoretical operations about which there is so much argument cannot really be the basis of the laboratory work, which remains unaffected. The extent of our

* Based on a lecture to the Measurements Section of the Institution of Electrical Engineers delivered on May 19.

agreement in practical matters shows that we must be working on some common basis. It is curious that it is so difficult to express it in terms on which we are all agreed.

Dr. Norman Campbell alone in recent years seems to have felt the necessity of maintaining a close and direct connexion between the principles and experimental laws which he enunciates as the basis of our measurements, and the methods that we actually employ in our everyday work. His work has, however, been strangely neglected in the recent discussions, and unfortunately, as he himself has pointed out, the matter is too complicated to be adequately covered by a few simple statements of the kind frequently offered. These are rightly used in introductory text-books, where it is expedient to conceal complexities until the more prominent ideas have been grasped, but when trying to find our basis the complexities must be faced. In these circumstances it would obviously be impossible to give here a precise statement of the position, but it may be of interest to indicate in broad outline some of its main features.

Measurement is essentially the derivation of numbers that are capable of representing physical properties in their relations to one another; and just as the various physical properties are defined by reference to the process adopted for their measurement, the numbers used in experimental physics are the symbols representing the results of the familiar physical or experimental operation of counting. The characteristic properties of numbers are the laws of addition, from which the other mathematical operations employed are derived, repeated addition leading to multiplication, the reverse operations providing subtraction and division, and so on. Thus the first condition to be satisfied in order that measurement may become possible is that some physical properties must obey laws that are analogous to the laws of addition for numbers. Another requirement is that operations must be devised that will enable us to judge of two objects, whether one is greater than, equal to, or less than, the other, in respect of some particular property. In short, judgments of equality and laws of physical addition form the basis of the whole problem.

It is generally agreed that in all our practical work we shall take length, mass and time as the primary properties, and probably everyone would agree with the statement that these quantities are all additive, though it is far from easy to say exactly what this statement means. Attempts to do so are apt to be tedious, but it is of interest to note that the measurement of these quantities depends only on the operations and principles mentioned above.

Length we define by reference to rigid rods. Judgments of equality are made by putting rods side by side and judging the alignment of fiducial marks or the coincidence of the planes of end-faces. Physical addition is performed with such rods by placing them end to end and in line. What justifies us in calling such a process addition ? Briefly, it has characteristics similar to those laid down in the laws of addition, commutative, associative and distributive, the essential ones being as follows. First, whenever we perform the operation an increase of length is brought about, as can be established by our ability to judge equality, etc. Secondly, if we apply the process to a number of such rods, the length of the combination is always the same, however the various operations are performed and in whatever order they are carried out.

It is easy to see that any property for which such a law of addition can be established becomes measurable if we can devise means for producing objects that are judged equal. We can by adding together many such objects produce a succession of systems of steadily increasing magnitude, which constitute a standard scale for that property. Any object to be measured is compared with the systems of the standard scale, and when the two are judged to be equal, we count the number of original equal objects in the composite system. The familiar devices for reducing the labour of counting, and for increasing the precision of the process by including subdivisions in the standard scale, depend only on the same laws of addition.

The direct application of these laws to measurements of length of the highest precision is well illustrated by the use of sets of slip gauges. The physical addition of these gauges by their wringing surfaces is daily giving results consistent to one millionth of an inch. The application to mass is too obvious to need description, but time and frequency differ somewhat from the other primary magnitudes. In practical work we are solely concerned with periods of time, a concept based on recurrent phenomena. In rotating and vibrating systems, we recognize certain features which recur regularly. These recognizable features are regarded as defining instants separated by periods of time, and we can judge instinctively whether two such instants are simultaneous or whether one is 'before' or 'after' another. We choose some definite system as a standard and define its characteristic periods as equal intervals of time. Then the time between any two instants is, by definition, to be measured by counting the number of recurrences of the standard, after the first instant and before or simultaneous with the second. Clocks are standard periodic systems attached to mechanical counting devices or adding machines.

Frequency, which is perhaps more important than time in electrical work, is merely another aspect of the same phenomena: it is just the number of recurrences of the system in each standard period. A clock without its calculating machine is a frequency standard. It is well known to all wireless engineers that laws for the physical addition, subtraction, multiplication and division of frequency of certain periodic electrical systems have been experimentally established and that actual measurements of frequency are often made with the highest precision in virtue of these laws. It is a fortunate fact of Nature that these laws are consistent with our notion of time, which is additive by definition.

Angle also should be regarded as one of our primary properties. It is essentially a property denoting difference or change of direction, that is to say, a property characteristic of the faces of rigid bodies like crystals, or alternatively, one characteristic of the operation of rotation or of rotating systems. There is a common delusion that the measurement of angle is based on that of length, but both 'static' angles and angles of rotation are in practice measured fundamentally using only laws of addition, and there is close correspondence between the two. Anyone who has calibrated a divided circle will know that measurements of length play no essential part in the process, but that the essence of the matter is the continued addition of a number ($n$) of equal rotations until exactly one complete turn has been made. Each of the equal rotations then bears the relation $1/n$ to one complete revolution. Obviously angles

of this kind are also measured whenever we count revolutions.

A most interesting illustration of the fact that angle of the other kind is measured fundamentally, and of its relation to rotation, is provided by a new system of angle gauges recently developed at the National Physical Laboratory by Dr. G. A. Tomlinson. They consist of pieces of hardened steel with plane faces $3\frac{1}{2}$ in. $\times$ $\frac{5}{8}$ in., inclined together at various angles and so truly plane that they can be wrung together to form combinations like length gauges. This is the process of addition. Equality of angles could be tested by the parallelism of corresponding faces, and thus starting with an arbitrary unit angle, standards of 1, 2, 2, 5, etc., or 1, 2, 4, 8, etc., could be established and any desired angle produced by addition. Tomlinson has, however, greatly simplified the practical problem by making use of the fact that if two equal standards are added with their directions reversed, their external faces are parallel, that is, their sum is zero: in other words, in this case physical subtraction as well as physical addition is possible, and therefore with a given number of gauges more combinations are possible. Tomlinson uses only twelve gauges of angles 3″, 9″, 27″, 1′, 3′, 9′, 27′, and 1°, 3°, 9°, 27°, 41°, and with these he can quickly produce any angle between 0° and 81° to within $1\frac{1}{2}$″ of its nominal value, some 97,000 possible values.

Measurements of angles of rotation can obviously be made with these gauges in conjunction with an auto-collimating microscope. The appropriate gauge is placed on the rotating member with one face perpendicular to the axis of collimation. The other face is, of course, not visible through the gauge, but it becomes available for inspection by wringing any plane reflecting surface on to it and arranging this surface so that it projects beyond the edge of the gauge and is thus exposed to the collimator. The rotating member is now turned until the second face becomes perpendicular to the collimator axis, as is shown by a zero reading in the eyepiece. The angle of rotation is then equal to that of the gauge. The gauges require no accurate centring, and provide a relatively simple method of measuring angle with the highest precision. Of the first four sets of gauges constructed at the National Physical Laboratory the average error was only 0·2″, and only three gauges out of forty-eight had errors so large as 0·5″.

Measurements of this kind, based solely on laws of physical addition and judgments of equality, are called by Norman Campbell fundamental or independent measurements. Not only are they employed for the most precise measurements of the primary mechanical properties; they are also employed for the most precise measurements of electrical properties. In the National Physical Laboratory, for example, they are employed for the basic measurements of resistance, capacitance and mutual inductance, and the laws of addition for these properties are the ones on which our electrical measurements primarily depend. Resistance is additive for conductors connected in series; capacitance for condensers connected in parallel; and mutual inductance for pairs of coils each consisting of a common primary coil and a secondary coil, when the secondary coils are connected in series. Standard scales for these quantities analogous to the scale of length are built up by the successive addition of resistors, condensers and inductors that are judged to be equal, the various bridges and balancing devices employed in making these judgments being detectors rather than measuring instruments, and serving only to amplify our senses.

Other electrical quantities which are additive are conductance, additive for conductors connected in parallel; electromotive force, additive for cells in series; and current, additive in circuits in parallel connexion. These quantities can all be measured fundamentally with high precision over a limited range. For measurements over a wider range other processes of measurement are used. For conductance we usually base our measurements on the law connecting it with resistance, which it may be noted is very similar to that connecting frequency and time.

Fundamental measurement is obviously severely limited in its scope, since each property is measured independently of any knowledge of any other property. But it is the relations between different properties that give to physical science its great scope, and modern experimental technique consists largely of measurements based on the numerical laws expressing these relations. It is important, however, to recognize that these numerical laws are entirely dependent on the laws of fundamental measurement that have previously been established for certain of the properties. It is only possible here to consider the first two or three in the sequence of derived laws which forms the basis of our experimental work. The great bulk of the electrical apparatus used in Great Britain is calibrated by instrument makers by reference to standards calibrated at the National Physical Laboratory, and therefore measurements made with this apparatus must be based on the laws adopted at the National Physical Laboratory for standardizing purposes.

The first of these laws is that connecting mutual inductance $M$ and geometrical properties. It can be written

$$M = \mu_0 N,$$

where $N$ denotes Neumann's integral $\iint \frac{ds_1\, ds_2 \cos \varepsilon}{r}$.

We have seen that for certain systems $M$ can be measured fundamentally. For many such systems $N$ can be expressed in terms of lengths and angles, which can also be measured fundamentally. It therefore becomes possible to establish with very high precision the law that for all mutual inductors constructed of non-magnetic material, $M$ and $N$ are proportional to one another, the proportionality constant $\mu_0$ depending only on the units adopted for $M$ and $N$ respectively. It can also be established that for inductors made of magnetic material the law becomes $M = \mu N$, where $\mu$ is constant for any one material, but varies with change of material. This law therefore provides a process for the measurement of the property $\mu$ characteristic of magnetic materials. It is the law defining magnetic permeability, and most of the usual methods of measuring permeability are directly based on it. The constant $\mu_0$ must now be interpreted as the permeability of all non-magnetic materials. We can regard it as having the dimensions 1 in inductance, and $-1$ in length, if we find the practice useful, and it is convenient to write its value as $10^{-9}$ henry per cm. The unit of inductance, the henry, has of course been fixed by assigning this value to $\mu_0$.

Our next law is that of the electrodynamometer, which forms the working basis of most of our measurements of current. It can be written

$$F = a\, I^2 \frac{dM}{dz},$$

where $F$ denotes the mechanical force between two coils when each carries the same current $I$, $M$ denotes the mutual inductance between the coils, and the $z$-axis is the direction of the force. This law has been established with the highest precision for the special case of the current balance built of non-magnetic material, the force $F$ being determined by weighing, in terms of mass, and the quantity $\frac{dM}{dz}$ by application of the law of mutual inductance in terms of the geometrical property $\frac{dN}{dz}$. $I$ can be measured fundamentally over a limited range, and thus the dynamometer law is established by means of the current balance in the form

$$mg = a\, I^2 \mu_0 \frac{dN}{dz}.$$

The proportionality constant $a$, unlike $\mu_0$ in the previous law, appears to be characteristic of no important property. We therefore choose our unit of $I$ so that $a$ takes the value of unity and disappears from our working equation, which becomes

$$F = I^2 \frac{dM}{dz}.$$

Next in the sequence is Ohm's Law, the law of the potentiometer, which can be established in the form

$$E = b\, I.R,$$

since both $E$ and $R$ can be measured fundamentally, while $I$ can be measured both fundamentally and by means of the dynamometer law. The constant $b$ appears to be characteristic of no important property and is therefore suppressed by a suitable choice of units for $E$ and $R$.

It is impossible to pursue the subject further here, but the examples given are sufficient to show the kinds of law that form our real foundations at the present time. These foundations change to some extent with changing technique. The basic laws are those of the instruments and operations which have enabled us to correlate our experiences with the highest precision, and have therefore been used in establishing our working standards. At the present time, alternating currents are employed for precision electrical work to an increasing extent, and therefore some of the laws concerning alternating currents are of basic importance. Note that the electrodynamometer law provides us with a means of measuring alternating current as well as direct current, and then by means of the electrostatic voltmeter we can extend Ohm's Law to certain classes of conductors, namely, resistors. Thus we can define and measure alternating potential difference. Faraday's Law of Induction can then be established in the form in which it states the relation between the alternating potential difference at the secondary terminals of a mutual inductor $M$ of which the primary carries a current $I$. Adopting the usual vector notation, we establish the law

$$E = kM\omega I,$$

and then choose the unit of $E$ so that $k = 1$. The constant $b$ which appeared in Ohm's Law is then suppressed by a suitable choice of the unit of resistance.

It is unfortunate that this system of laws, upon which our experimental work is based, does not readily link up to form a simple logical development of the theory of the subject; but once we have recognized the great difference between the basic experimental laws and the theoretical relations which have been devised as the simplest easily workable system consistent with these laws, we are prepared to find differences of opinion as to which theoretical scheme can be used with the least risk of confusion.

# PSYCHOLOGICAL ASPECTS OF MORAL PROGRESS

A WIDESPREAD readiness to re-examine human values makes it particularly appropriate at the present time to ask whether recent scientific work can add to our understanding of moral advance. This was the question taken up in a discussion on "Psychological Aspects of Moral and Social Progress" at a meeting of the British Psychological Society on September 23, in which the chief speakers were Prof. J. C. Flugel, Prof. Karl Mannheim and Dr. R. H. Thouless.

In opening the discussion, Prof. Flugel suggested that, as a first approximation, we may identify eight mental tendencies exhibited in what we regard as moral progress. Once recognized, they can be illustrated in three fields of comparison: they differentiate the mind of the infant and child from the more mature mind, the abnormal (pathological) mind from the healthy mind, and the primitive from the civilized culture. These eight tendencies may be briefly stated.

(1) There is a trend away from ego-centricity and towards sociality, an increasing readiness to subordinate one's own immediate requirements to the needs of one's fellows, and to find satisfaction in the well-being of groups ever more broadly conceived, so that what starts as a concern for a few family associates may develop into loyalty to a nation, a church, or the whole human race. Among the psychological mechanisms involved in this process, an important part is played by vicarious satisfaction; our interest goes out to people very different from ourselves because they represent some of what William James called the 'potential selves' which we all give up in becoming our own one self.

(2) Progress towards greater consciousness, away from the control of conduct and feeling by unconscious urges, also appears in the advance towards individual maturity and civilized social organization. Progress along this line is pre-eminently the aim of psycho-analysis. At the same time, it must be recognized that, conscious scrutiny having thoroughly performed its task, much behaviour has to be relegated to the habitual and the automatic. Individual conscious life is supported by a mass of habits, reflexes, and other non-conscious determining tendencies. In social life, traditions and conventions have a similar role. Their value lies in the economy they effect, their danger in that they may grow antiquated and ill-adapted; but they must always be necessary in mental and social organization, simply because the span of consciousness at any one time is strictly limited.

(3) The trend towards realistic thinking, away from dreaming and 'wishful thinking' in individual life, and away from magic in social life, is a third mark of advance. Science, Freud has suggested, is essen-

tially an endeavour to think according to the 'reality principle'.

(4) Social and individual progress shows a gradual replacement of aggression by tolerance. Primitive and infantile mortality is marked by a sweeping aggressiveness which gives place in later development, to finer discriminations and broader tolerance. The mature mind can better tolerate unwelcome stimuli, including new points of view, and has less need to react in aggressive defence of things as they are. In one respect this appears as the toleration of criticism which is vital to science; in another as that capacity for 'collaboration in opposition' which Madariaga has noted particularly in the British national character.

(5) A trend is to be seen in individual and social advance towards spontaneity in doing what is regarded as right, in contrast to the more primitive reliance on strong prohibitions against 'wrong' impulses after they have arisen. In the child's development, the external prohibitions are replaced by the internal control of the super-ego, and with increasing maturity the conflict grows less between the super-ego and the impulses it controls. One aim of psycho-analysis is to replace the crude inhibitory power of the super-ego by the ego's more delicate discrimination. So, too, right behaviour among primitive groups depends more on taboos and the avoidance of sins, but in civilized societies more upon the sublimation of impulses into permissible channels.

(6) A progressively greater freedom from irrational anxieties is seen in the child's development and in the advance from primitive to civilized societies, superstitions and phobias being shed, bogies of all kinds less and less remembered. In psycho-analysis the patient's progress exemplifies the same trend.

(7) As development proceeds, the individual shows increasing self-responsibility. In controlling his behaviour he judges with greater autonomy, and is less at the mercy of the ready-made morality of the group or the super-ego. The same tendency is seen socially in the advance from generalized taboo to reliance on individual conscience; and, politically, towards democracy instead of submission to a dictator.

(8) The eighth developmental trend shows moral judgments increasingly penetrated by intellectual understanding. The cognitive approach to what we disapprove of begins to displace the mainly affective and conative procedures of condemnation and attack. In reply to discussion on this point, Prof. Flugel made it clear that a moral judgment must always remain, and action must be taken against what we condemn; but with increased maturity the means adopted will be chosen in the light of much fuller intellectual understanding. The handling of delinquents illustrates the point: the modern effort to investigate, to view separately the sin and the sinner, is an advance beyond the simple condemnation and punishment which, considering that they have been practised for some millennia, have achieved relatively little.

Prof. Flugel suggested these eight tendencies only as a first approximation, and he later inclined to agree with Dr. Thouless that a ninth should be added—the tendency towards greater voluntary control of action, the passage from uncontrolled to controlled behaviour. While adding this ninth tendency, however, Dr. Thouless was emphatic that he could not regard such tendencies as aspects of 'progress'. He viewed them as a description in psychological terms of the criteria by which we distinguish between the better and the worse in conduct. That the better does in fact come later in the life-history of the individual and the social group is a separate question, to be decided only by an examination of the facts of child psychology and of anthropology. The term 'moral progress' implies an answer to this question, which may or may not be true. He doubted, for example, whether the tendency towards sociality and away from ego-centricity is greater in civilized than in primitive groups.

Prof. Mannheim, reading the first paper in comment upon Prof. Flugel's thesis, had already given critical attention to the concept of 'progress'. Speaking as a sociologist—and welcoming a discussion that brought both psychology and his own science to bear on the problem—he pointed out that the notion of progress grew up in the nineteenth century, an era of industrialization and economic expansion. Impressed by the seemingly endless possibilities of material advance, thinkers of the time carried over the same optimistic attitude into their view of the human mind. But this confidence in social and moral advance as an inherent feature of the historical process has been deeply shaken by the political and international events of the twentieth century.

In Prof. Mannheim's view, society shows no inevitable cultural development through recognizable stages. Such a phenomenon as Germany's return to the tribal mind and over-socialization is not to be termed a 'regression', for the trend in the opposite direction is not a normal or natural process. To suppose that it should be, is to blind ourselves to the more important moulding of behaviour by environmental conditions. For a detailed understanding of a group at any period our chief need is, not to know what point it has reached on a linear scale of progress, but to relate its current mental attitudes to its concrete environment, social and technical.

As an example, Prof. Mannheim pointed out that an industrial society, appearing late in the historical sequence, may nevertheless produce—through its uniform repetitive tasks and its social institutions which reduce the opportunity for individual choice—far less individualized personalities than an earlier society without mass production. It depends on the particular organization of society whether the trader, for example, grows acutely aware of the difference between his own interests and the interests of others, as he did under *laisser-faire*, or whether he thinks rather in terms of collective action by a group of associated merchants or a guild of craftsmen.

As a member of our contemporary culture, Prof. Mannheim is ready to agree that he, too, values the eight tendencies which Prof. Flugel identified. But as a sociologist he challenges the frame of reference within which the psychologist makes his judgments.

Dr. Thouless, in his comment on Prof. Flugel's paper, not only objected to the suggestion that the eight tendencies represent 'progress', but also doubted whether they are all aspects of any single process or at all closely related with one another. For example, one might go far towards realistic thinking (3) without becoming any less aggressive (4). Rather than assume a unified stream of progress we should do better to recognize that there are many ways in which men and societies can improve.

Like Prof. Mannheim, Dr. Thouless stressed the limitations of moral judgments made within our contemporary frame of reference. Thus our own readiness to talk as if aggressiveness were the principal evil may seem to later observers as relative and

peculiar a characteristic as the nineteenth century's readiness to regard sexual indulgence as the chief of sins. Again, the sense of guilt has gone through cultural vicissitudes. Puritanism made it a moral good in itself. Psycho-analytic writers now speak as if it were merely pathological. But it has a valid function to perform: it can serve to deter us from a repetition of those acts which we ourselves condemn. In fact, in Dr. Thouless's opinion, the modern tendency to belittle the idea of sin goes too far. The fact of sin (whether we take a religious view of it or not) occurs whenever a man's voluntarily controlled behaviour falls short of his own accepted standards. Even in these modern times, we retain a vivid sense of sin when others commit it; nowadays a man is prone to repent of his neighbour's sin and to apply the light of scientific understanding to his own.

In general, Dr. Thouless believes that the psycho-analytic approach represented by Prof. Flugel's eight principles suffers from an intellectual bias. It describes moral betterment as if that were primarily a matter of getting better principles and moral ideas, and seems to neglect the problem of bringing actual behaviour into line with those moral principles. For this reason he proposed the ninth tendency already referred to—a progressive increase in the voluntary control of conduct. But, as he was careful to point out, this trend by itself does not ensure an improvement in conduct, since voluntary effort may be directed towards wrong ends. The ethical questions remain.

The meeting was left to decide whether, as Dr. Thouless suggested, the effort to discuss the nature of right and wrong in the new technical language of psycho-analysis is primarily a test of the adequacy of that language; or whether, as Prof. Flugel holds, certain psycho-analytic conceptions, such as that of the super-ego, actually throw new light on moral problems.

# OBITUARIES

## Prof. Gustav Gilson

NEWS comes from Belgium that M. Gustav Gilson, embryologist at Louvain, fisheries expert at Ostend, died last winter. He was eighty-two years old, and though he kept busy to the end the best of his work was done well-nigh sixty years ago.

Gilson was Carnoy's favourite pupil: when Carnoy started his famous journal, *La Cellule*, Gilson figured as co-editor, and the first number contained his "Etude comparée [or part of it] de la Spermatogénèse des Arthropodes". The next was by Carnoy himself, "Sur la cytodiérèse chez les Arthropodes", in other words, on mitotic cell-division. It was a great enterprise to start this costly journal in a small university like Louvain; but natural science was no new thing in that University. It was there that Theodor Schwann wrote his "Observations microscopiques", and laid the foundations of the cell-theory. P. J. van Beneden had been professor there for forty years, and his "Ostéographie des Cétacés" was famous. His son Edouard was a leading embryologist of F. M. Balfour's time, and had just published a paper which became classical, on the egg of *Ascaris megalocephala*; but he left Louvain for Liège (as Schwann also had done), and Louvain and Liège seldom saw eye to eye. Other papers of Gilson's, more or less important at the time, were for example on "Les glandes odorifères de Blaps mortisaga" (1886); a whole series on "La soie et les appareils séricigènes" (1890–94); and a careful histological study of "Les cellules musculo-glanduleuses de l'Owenia", a genus of Annelides (1898). When Carnoy died all too soon in 1899 Gilson pronounced the customary *Éloge*, and did it with grace and tenderness: he carried on *La Cellule* as sole editor until it came to an end, like much else in Louvain, during the War of 1914–18.

Gilson carried on the Department of Zoology well and efficiently, but did little more histological or embryological work after Carnoy's death. He had a family connexion with Ostend, and the latter years of his life were spent there; he began to interest himself in the local fisheries, and in course of time established a Fisheries Laboratory, and even issued a journal (*Annales de l'Institut*) in connexion with it. He was not one of the founders of the Conseil International, but he took part in our second meeting in Copenhagen (1903), and attended regularly thereafter. One of the first of his fishery publications was on the reproduction and migrations of the eel, a burning question at the time; another, about 1910, was an elaborate statistical study of the great plaice-fishery; yet another, and an interesting one, was on the 'Guai', or winter-herring of the Belgian coast. Other fishery papers mostly dealt with the busy fleet of motor and sailing cutters, trawling and shrimping off the Belgian coast, and landing, or still worse destroying, prodigious quantities of 'undersized' fish. A report which he made to the Council in 1928 was the completest account of such a fishery that had ever been drawn up, and the many million of small fish destroyed made a startling story.

Gustav Gilson married late in life, but very happily. He was reticent of speech, austere of manner, of grave and intellectual countenance; during fifty years acquaintance I found him a faithful friend, a real scholar and a true man.

D'ARCY W. THOMPSON.

## Mr. H. Tetley

MR. H. TETLEY, curator in zoology at the Bristol Museum and Art Gallery, died on September 26 at the relatively early age of fifty-four. Educated at Malvern College and graduating B.Sc. in the University of Leeds in 1916, he carried out postgraduate research in entomology in the University of Manchester. During the War of 1914–18 he served as a paymaster in the R.N.V.R. and on demobilization was appointed assistant demonstrator in zoology and curator of the zoological museum in the University of Sheffield.

After a serious illness—the effects of which really undermined his health for life—Tetley was appointed in 1927 to take charge of the Zoological Department of the Bristol Museum and Art Gallery. There he overhauled the extensive collections, prepared and arranged new exhibits, and instituted the organization of records concerning the local distribution and occurrence of many groups of animals. It was a severe blow to him when in 1940 many of these records and much of the collections were destroyed by enemy action. He was especially conversant with local birds and mammals, and his publications reflect these interests. Many of these papers were published in the *Proceedings of the Bristol Naturalists' Society*, and by far his most important work was an

extensive paper on the "Land Mammals of the Bristol District" published in 1940. Papers on British pole-cats, the Scottish fox and wild cat were published in the *Proceedings of the Zoological Society* between 1939 and 1941 and various notes appeared between 1933 and 1942 in *British Birds*.

Tetley was a first-class observer in the field, and was always ready to place his comprehensive knowledge of local animals at the service of interested inquirers. Many of his papers bear witness to these detailed observations, while others give evidence of his bibliographical researches and are fundamentally compilative in character.

He held several offices in the Bristol Naturalists' Society, being president at the time of his death. He was a fellow of the Zoological Society of London and was recently engaged upon collecting details for the third volume of the International Wildfowl Inquiry Committee and the University of Bristol sub-Committee of the Nature Reserves Investigation Committee. For several years he had been special lecturer in systematic zoology at the University of Bristol, where he also rendered valuable service in connexion with the Wiglesworth Library of Ornithology.

Dogged by ill-health, never strong and robust, Tetley carried out his duties faithfully even under adverse conditions. Of a gentle disposition, though rather non-receptive to new ideas and policies, he was held in high esteem by local naturalists, and the sympathy of his colleagues and friends is extended to his widow and two children.

F. S. WALLIS.

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WE regret to announce the following deaths:

Prof. C. G. Barkla, F.R.S., professor of natural philosophy in the University of Edinburgh, on October 23, aged sixty-seven.

Dr. Olaf F. Bloch, formerly chief chemist of Ilford, Ltd., on October 19, aged seventy-two.

Prof. M. R. Wright, M.B.E., emeritus professor of education, University of Durham (King's College, Newcastle upon Tyne), on October 10, aged ninety.

# NEWS and VIEWS

## Prof. H. T. Flint

PROF. H. T. FLINT, the new occupant of the Hildred Carlile chair of physics in the University of London in succession to Prof. W. Wilson, was one of the latter's colleagues at King's College, London, in the days immediately following the War of 1914–18. Like his predecessor, he is chiefly interested in the theoretical aspects of physics and has made many highly original and important contributions to relativity and quantum dynamics. He showed that Wilson's quantum conditions fix an upper limit to the number of the chemical elements and gave an explanation of the existence of the elementary charge. The introduction of a matrix-length into the geometry of the microphysical world and of the imaginary gauge is due to him, and his work has anticipated much of recent nuclear field theories.

Prof. Flint's activities are by no means confined to theoretical subjects. He has recently devised a new method of measuring dielectric constants and absorptions, which has the merit of eliminating errors due to fluctuating input and enables dielectric properties in the region of centimetre, or even millimetre, waves to be investigated. He is also an expert on the manipulation of radium for hospital purposes. He is the author of well-known works on wave mechanics, geometrical optics and, in collaboration with Dr. Worsnop, of a much used text-book of practical physics.

## International Convention for Civil Aviation

A WHITE PAPER, issued recently, lays down the British Government's policy for the future control of civil aviation. It visualizes a radical change from the pre-war outlook, proposing a new air convention covering six main objectives to be secured by international agreement. Proposals have already been made by the Canadian Government, and other Commonwealth Governments are known to hold favourable views. Previous to the War, regulation by agreement was confined to technical aspects covering safety, the right of innocent passage across territory and access to aerodromes. This convention, although ratified by thirty-three States, was never adopted by the United States, the U.S.S.R. and China. Many countries heavily subsidized their air-transport companies, either for national prestige or war potential, and consequently bargaining for international flying rights became political and gave rise to much friction. The new proposals would cover the economic and commercial, as well as the technical aspects, and thus by agreement avoid the political and narrow national outlook in administering air transport over world routes.

The British Government suggests that the proposed convention will secure the following objectives: (1) meet the needs of the world for plentiful, efficient and cheap air transport; (2) maintain equilibrium between the world's air transport needs and capacity; (3) ensure an equitable participation of each country in the world's whole air transport scheme; (4) eliminate wasteful competition and in avoiding unnecessary expenditures and fixing rates of carriage, limit the need for, and to control, subsidies; (5) standardize technical matters dealing with the safety of flight; (6) contribute to world security by encouraging international travel and exchange. It is suggested that the administration should consist of an international air authority, with operational executive panels, probably regional, and sub-commissions to deal with technical matters. The authority would consist of representatives of the ratifying States, and would need to be placed in proper relationship to any world security organization as may exist. The composition of the executive and technical bodies would have to be by mutual agreement between the air authority and the ratifying powers. The Government has explained that these proposals are a broad outline only, and may need to be modified in the light of views expressed by other countries.

## Gift to University of Leeds

MR. CHARLES BROTHERTON has just given the University of Leeds (1) £1,000 a year for seven years for the establishment of a Brotherton research fellowship in physical chemistry tenable in the Department of Colour Chemistry and Dyeing; (2) £1,000 a year for seven years for the establishment of a new lectureship in chemical engineering in the Department of Coal Gas and Fuel Industries; and (3) an additional sum of £1,000 to each of the two Departments for the purchase of equipment.

These are not the first gifts which have come to the University of Leeds from Mr. Brotherton. In September 1940 he provided a valuable addition to the resources of the Colour Chemistry and Dyeing Department by providing funds for the institution of two Charles Brotherton entrance scholarships tenable by students reading for the degree of B.Sc. with honours in colour chemistry, and two years later he increased the number of scholarships to three. Mr. Brotherton has expressed his gratification at the success of this scheme and has now extended his interest in the work of the Department by his further contributions. For some time past the investigation of problems of fibre technology, dyeing and some aspects of colour chemistry has necessitated the increasing application of methods of physical chemistry. The addition of a physical chemist to the staff of the Department has long been desirable; but the mere institution of such a post would have been ineffective in the absence of a suitably equipped laboratory. Mr. Brotherton's generous gift, which allows complete freedom in the expenditure of the funds as between the salary of the research fellow and the equipment of an appropriate laboratory, will make possible at an early date the realization of this most important development.

The Department of Coal Gas and Fuel Industries with Metallurgy, which also benefits by Mr. Brotherton's latest gift, co-operates with the Institution of Gas Engineers in research supported by the Institution and guided by a joint committee of the Institution and the University of Leeds. The Livesey professorship was endowed in 1908 from a fund raised by public subscription from the gas industry in memory of the late Sir George Livesey. The Department has for some thirty-seven years provided degree courses in fuel and metallurgy. The training in gas engineering has been based on chemistry and engineering, followed by instruction embracing chemical engineering and fuel technology, mainly to meet the needs of the gas industry. A separate curriculum was established in 1942 in chemical engineering and is intended to provide instruction particularly in plant design and in the so-called unit processes of the chemical industry. It meets the special need of those passing either into the contracting side of the gas industry or into the chemical industry generally. The provision of up-to-date equipment and staff in such technological departments is costly, and the University has largely to rely on the support of industry. Mr. Charles Brotherton's generous gift to provide for the special needs of chemical engineering is most opportune and should materially help to establish one of the best training grounds in the country. The need is vital, for British universities have been unable during the years between the two wars to make advances in this field comparable with those of the United States.

## An International Association of University Teachers

THE sixth general meeting of the Association of Allied University Professors was held in London on September 25. The meeting was called specially to consider the statutes for a proposed International Association of University Professors and Lecturers. These were, after some amendment, adopted as provisional statutes, so that what has hitherto been a domestic association, bringing together those university professors and lecturers of the Allied countries who, in recent circumstances, have reached Great Britain, now takes on a wider international function under a new name. It is hoped that in each country where there is academic freedom a national group of members may come into existence. In order to establish contacts and bring into being such groups, a Provisional Central Council has been formed, mainly of university teachers of various nationalities who are domiciled in Great Britain, the duty of each member of which is to arouse interest in the Association in the universities of his own country. As soon as circumstances permit, representatives from these countries will replace the original provisional member and the Central Council will become a representative body, and will confirm or amend the statutes. The Provisional Central Council at present comprises members representing some twenty different countries, and it will be enlarged as further contacts are made. One result of the change in structure of the Association will be that in Great Britain, where membership has hitherto been restricted in order to preserve some balance between British members and those from other countries, membership will now be widely open in university circles. After the more formal business of the meeting was completed, Dr. Grayson N. Kefauver, of the American Educational Delegation, gave an address on "The Role of the University in Social Reconstruction".

## British Standards Institution

THE annual general meeting of the British Standards Institution was held on October 17, when Lord Woolton was elected president, Sir Percy Ashley vice-president, and Sir William Larke succeeded Sir Percy Ashley as chairman of the General Council. Dr. E. F. Armstrong, chairman of the Finance Committee, explained that the income and expenditure for the year had increased by 28 per cent and was now about £69,000. The sales of copies of British Standards had gone up 39 per cent. The Government grant-in-aid was nearly double and was now £12,900. While there was an increase of some 15 per cent in the number of subscribing members he pointed out the need for greater support from local authorities and industry. Sir Percy Ashley concluded his term of office as chairman of the General Council with a brief review of the work done as a direct aid to the war effort by the British Standards Institution, and the progress made during the same period in the preparation of British standards for industrial and commercial materials and appliances. The war work covered the preparation of war emergency British standards for A.R.P. materials for the Ministry of Home Security, packaging schedules and code for the Ministry of Production, steel and non-ferrous metal standards as well as standards for many other materials, tools and appliances for the Ministry of Supply and for the Services generally, and schedules for clothing and hardware for the Board of Trade. Many of the war emergency standards were made

compulsory by the issue of statutory rules and orders. The preparation of standards for building materials and appliances now being carried out in support of the programme of house-building of the Ministries of Works and Health has already reached substantial proportions. Sir Percy concluded by emphasizing the importance of industrial standards, which provide for accurate and precise trade descriptions, methods of sampling and testing, and standards of performance, and of an independent body, set up and maintained by the national industry as a whole, with Government support but not under Government control, for the preparation of such standards. Progress will be most widespread and continuous if the policy of 'standardization by consent' is consistently pursued.

### Harvesting Machinery

THE inaugural meeting of the 1944–45 session of the Institution of British Agricultural Engineers was held on October 17 at the Institution of Electrical Engineers under the chairmanship of Mr. C. I. C. Bosanquet, and Mr. Cornelius Davies read a paper on harvesting machinery. Mr. Davies, who has for many years been closely associated with the South-Eastern Agricultural College at Wye, Kent, traced the developments in methods of harvesting from the earliest times to the present day. His paper dealt not only with the harvesting of corn and potatoes but also with machinery for handling sugar beet, grass, silage, hops, vegetables and fruit. On the combine harvester Mr. Davies reminded the audience that this machine cuts and threshes the grain in one operation, and there is no period in the stook when final ripening can take place. Adequate drying facilities are necessary, and serious attention to grain storage is required. Nearly all combine owners are faced with a straw problem. He considers that to burn straw is evidence of bad husbandry. On some farms pick-up balers are used, but the cost of these is nearly as high as that of a combine; further, the use to which the baled straw can be put must be considered.

On the question of potato harvesting Mr. Davies discussed the relative merits of the spinner and the elevator lifter, and stressed the need that still exists for a really satisfactory potato harvester. In conclusion, Mr. Davies stated that in addition to the provision of more and better harvesting machines, there must be more skill in handling and greater care in maintaining and managing agricultural machinery. In the discussion which ensued, community ownership of expensive machines, the employment of contractors, and the development of simple and relatively inexpensive machines within the scope of private ownership on small farms were discussed.

### Cultural Co-operation

UNDER the title "The Cultural Co-operation Program 1938–1943" (Washington: Govt. Printing Office. 15 cents), the U.S. Department of State has issued a report by H. Hanson describing the development since its inception of this programme for fostering international relations on a basis of mutual understanding and appreciation. The programme is conceived by the General Advisory Committee of the Division of Cultural Relations as a long-term one of continuing activities which should be as broad as intellectual and cultural activities themselves. A statement of policy issued by the Department on March 31, 1944, on the participation of the United States in educational and cultural reconstruction in Europe, indicated the Department's intention of co-operating in the formation of a United Nations organization for educational and cultural reconstruction. This emergency programme to meet this need may consist of assistance in restocking essential educational facilities, especially books and scientific and other teaching aids; in the provision of opportunities for training carefully selected foreign students in American educational institutions; in re-establishing essential library facilities; and in the recovery and restoration to their rightful owners of scientific, artistic and archival materials looted by the Axis countries. The report includes some notes on professional and scientific relations, and on the various activities under the programme: these include travel and study grants, including student exchange, and the provision of technical experts for China; cultural centres, such as libraries, including the reference library opened by the Office of War Information in London in December 1942, which seeks by a careful loan service to place each new American book in the hands of selected people in the British Isles; cultural materials, such as books for libraries in the Western hemisphere, book translations, microfilms for China and the Near East, science news letters and motion pictures and radio activities.

### Pitfalls of Positivism

IN a most timely article entitled "Positivism" (*Mind*, July 1944), Prof. W. T. Stace throws great light on the doctrinaire character of the so-called logical positivists. After making a useful distinction between the 'meaning' of a word and the 'significance' of a sentence, he states the positivist principle as follows: "what makes a sentence significant is that some actual or possible observation can be deduced from it in conjunction with certain other premises, without being deducible from those other premises alone". He then makes his main point, that underlying this principle is another one more fundamental, which he calls the "Principle of Observable Kinds", and states as follows, "a sentence, to be significant, must assert or deny facts of a kind such that it is logically possible directly to observe some facts which are instances of that kind".

Prof. Stace points out that this principle is different from the positivist principle in that it introduces the notion of direct verification, whereas the positivist principle makes use of that of indirect verification. Further, this latter principle neither follows from the positivist principle nor is it self-evident. Nor again does it follow from the empiricist principle which states that all our simple ideas come from impressions, because this provides no guide as to how the former are to be combined to make significant sentences. In fact, Prof. Stace holds that there is no reason to think the principle true. It would follow that we should discard it and with it the positivist principle, if in fact this latter is based on it. But the proof which Prof. Stace gives that the two are related in this way is weak. Nevertheless, all those inclined to flirt with modern forms of positivism should study the article.

### Physical Society's Exhibition of Scientific Instruments and Apparatus

THE Physical Society's long and almost continuous series of annual exhibitions of scientific instruments and apparatus was, of necessity, suspended during the War. Its resumption has recently been considered by the Council of the Society and by the Exhibition

Committee, now under the chairmanship of Prof. G. I. Finch, who succeeds the late Mr. R. W. Paul, and it is proposed that the thirtieth exhibition (which was planned to take place in January 1940) shall be held in January 1946. It will take place in the Physics Department of the Imperial College, Imperial Institute Road, London, S.W.7, as on previous occasions, and will be on about the same scale as the exhibitions of the immediate pre-war years.

## Edward Emanuel Klein, F.R.S. (1844–1925)

DR. EDWARD EMANUEL KLEIN, a pioneer in histological and bacteriological research, was born at Ersek in Hungary on October 31, 1844, and studied at Vienna, where he devoted himself to microscopic anatomy. In 1869 he came to England and served at first as histological assistant to Burdon Sanderson, but afterwards devoted himself entirely to bacteriology, of which he was the first representative in England. He was lecturer in histology and later of bacteriology at St. Bartholomew's Hospital Medical School, where Ronald Ross was one of his pupils. He was the author of "The Anatomy of the Lymphatic System" (1873–75), "Atlas of Histology" with Mr. Lobb Smith (1879–80), "Elements of Histology" in collaboration with J. G. Edkins (1883), "Micro-organisms and Disease" (1884), "Asiatic Cholera" (1884) and "Oriental Plague" (1906). He was also collaborator in a "Handbook for the Physiological Laboratory" (1873). He was elected a fellow of the Royal Society in 1875. He died at Hove on February 9, 1925.

## The Night Sky in November

NEW moon occurs on Nov. 15d. 22h. 29m. U.T. and full moon on Nov. 30d. 00h. 52m. The following conjunctions with the moon take place: Nov. 5d. 00h., Saturn 0·1° N.; Nov. 10d. 18h., Jupiter 4° S.; Nov. 17d. 05h., Mercury 5° S.; Nov. 19d. 02h., Venus 3° S. The following occultations of stars brighter than magnitude 6 take place: Nov. 2d. 23h. 12·0m., *i* Tauri (*R*); Nov. 3d. 22h. 06·1m., 20° 1105*m* (*R*); Nov. 8d. 04h. 19·1m., 8 Leon. (*R*). The times refer to the latitude of Greenwich and *R* refers to reappearance. Mercury sets 8 minutes after the sun on Nov. 1 and 52 minutes after the sun at the end of the month. Venus can be seen in the evenings, setting at 17h. 45m., 18h. 12m., and 18h. 18m. at the beginning, middle and end of the month respectively. Mars is too close to the sun for favourable observation. Jupiter rises at 2h. 19m. at the beginning of November and can be seen about midway between $\sigma$ and $\upsilon$ Leonis. At the end of the month the planet has moved into the constellation of Virgo and rises at 0h. 48m. Saturn, in the constellation of Gemini, sets at 12h. 09m., 11h. 12m. and 10h. 11m. at the beginning, middle and end of the month respectively. The times have been computed for the latitude of Greenwich and the effects of refraction are ignored in all cases. The Leonid meteors are due on November 13–14 but the shower has been very feeble for some years, and the same remark applies to the Andromedids, which were once fairly active during November 18–27.

## Announcements

AT a meeting of the Council of the Royal Society held on October 12, amendments were made to the statutes so as to make it clear that, since the passing of the Sex Disqualification (Removal) Act of 1919, there is no barrier to the admission of women into the fellowship of the Society. This decision was reached after the fellows of the Society had been consulted by postal vote and had approved the amendments ratified by the Council on that day.

THE U.S. National Academy of Sciences, which serves as an official liaison agency between American scientific men and the Government, is to receive the Ordnance Distinguished Service Award of the U.S. Army. In a letter to Dr. Frank B. Jewett, president of the Academy, Maj.-General L. H. Campbell, jun., Chief of Ordnance, says: "It is my pleasure as Chief of Ordnance of the Army to tell you on behalf of the Ordnance Department that I am most grateful for the outstanding contributions the National Academy of Sciences has made to Ordnance progress in this war. The degree of that progress is best shown by the success of our fighting forces in all theaters of operations".

THE Lord President of the Council has appointed Sir Robert Robinson to be chairman of the Water Pollution Research Board of the Department of Scientific and Industrial Research, in succession to the late Mr. H. C. Whitehead.

MR. A. V. WILLIAMSON, reader and head of the Department of Geography of the University of Leeds, has been elected to the newly instituted chair of geography, as from the beginning of the present session. The title of honorary reader in the history of economic theory in the University has been conferred on Mr. H. D. Dickinson, lecturer in economic history.

SIR SAMUEL COURTAULD has offered the University of Oxford £2,000 a year for seven years, for research into the relative efficiency of small- and large-scale business and allied problems of industrial structure and organization and kindred subjects, to be carried out under the direction of the warden and fellows of Nuffield College.

FOR the third successive year, a course of lectures on the application of statistical methods to industrial problems is being given by Dr. B. P. Dudding at the University of Sheffield on Friday evenings, commencing October 20. These lectures are of a rather more advanced type than those given in earlier courses and although primarily intended for students of engineering are open without charge to suitably qualified men from industry.

THE following scholarships, which are tenable for three or four years, according to the length of the course at the university selected, will be offered for competition by the Institution of Naval Architects in 1945: Martell Scholarship (£130 per annum); Trewent Scholarship (£125 per annum) in naval architecture; Denny Scholarship (£130 per annum) in marine engineering. The Denny Scholarship, age limit nineteen, is tenable for four years at the University of Glasgow only, with apprenticeship of five years. Entries for the Martell Scholarship close on January 15, and for the other Scholarships on May 31. The Wrought Light Alloys Development Association Research Scholarship (£400 per annum, tenable for two years) is to be awarded to graduates in applied science preferably less than thirty years of age on October 1, 1945: entries close on July 31. Particulars can be obtained from the Secretary of the Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Filamentous Carbon

P. AND L. SCHÜTZENBERGER[1] reported that when cyanogen was passed down a porcelain tube containing gas carbon with powdered cryolite on its surface, heated to a cherry-red heat, decomposition occurred and elementary carbon separated in a bulky mass of very slender filaments. The filaments had some elasticity, were friable and marked paper. When aluminium was mixed with the gas carbon, non-elastic filaments separated round it which, on gentle compression, resembled graphite.

FIG. 1.

This filamentous or woolly form of carbon is sometimes found in beehive and recuperative coke-ovens, particularly near the ascension pipe. C. and H. Pélabon[2] found that the wool consisted chiefly of grey cylindrical threads with a glazed surface and occasional bundles of much finer threads. The average length of the threads was 5 cm. and the diameter varied between 0·03 and 0·15 mm., the finer threads being only about 0·002 mm.

A similar filamentous form of carbon has been obtained by cracking methane, diluted with nitrogen, hydrogen and carbon monoxide on an iron surface at 1,000° C. The bulk of the carbon was deposited in the form of a hard, brittle, grey mass, on the surface of which was a large number of slender carbon filaments all running more or less parallel to each other (Fig. 1). These filaments are very fragile, but we succeeded in mounting a small bundle of them and taking an X-ray photograph. Unfiltered cobalt $K$-radiation was used with a specimen to film distance of 48 mm. The photograph (Fig. 2) indicates that the carbon present is the ordinary 'amorphous' variety ($\theta_{002} = 14 \cdot 8°$, inter-layer plane spacing about 3·5 A.) with the $c$ axis perpendicular to the fibre axis, that is, the hexagon layer planes more or less parallel to the fibre axis, with a maximum deviation of about 30°.

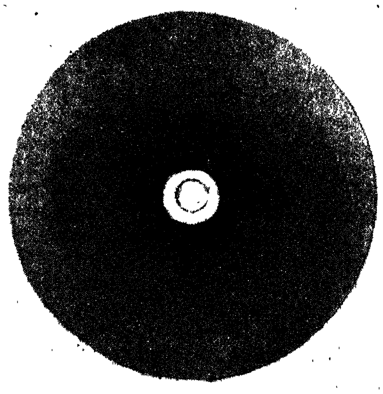

FIG. 2.

So far as we know, this is the first example of a fibre built up from lamellar units.

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[1] *C.R. Acad. Sci.*, **111**, 774 (1890).
[2] *C.R. Acad. Sci.*, **137**, 706 (1903).

## The Divergence Difficulty of Quantized Field Theories

IN the theory of interaction of particles like photons and electrons or mesons and nucleons, etc., the experiments are always made in such a way that the different kinds of particles are observed in different parts of space with different instruments. In these parts of space one can speak of pure kinds of particles and describe them by pure quantized fields—Maxwell's field, Dirac's field, etc. However, in the part of space where the collisions really take place, the pure fields are not simply additive but have to be supplemented by an interaction field. All effects due to the interaction can be obtained by considering the stationary states of the whole system.

Because of the complication of the problem, one has to use a method of successive approximation called the perturbation method in which the interaction is regarded as small. It is well known that then special care must be taken to remove the degeneracy of the states of the unperturbed system in a way so as to anticipate the eigenstates of the perturbed system. This preliminary step has, however, been ignored in the usual practice for the interaction of fields; and consequently divergent expressions appear as soon as the next higher order of the perturbation method is attempted.

The results obtained by the usual practice were in good agreement with observations in the case of the photon-electron interaction, although the divergence of the higher approximation indicates that some mistake must have been made, which might be physical or mathematical. No such agreement with observation has been found in the case of the meson field. Some time ago an improved method[1] based on physical reasoning was developed which takes account, to the first approximation only, of what is classically known as the 'radiation reaction'. This method is well confirmed by its applications, especially to the meson field, but hitherto its theoretical basis was not satisfactorily established.

It has now been found that this provisional method can be rigorously established by a systematic application of the ordinary perturbation theory for degenerate systems adapted to the case of the continuous

spectrum. I have found that the treatment of the radiation reaction referred to above constitutes exactly the preliminary step of the removal of degeneracy. The continuation of the perturbation method to higher approximations is then possible without any difficulty.

With this mathematical improvement, it might be that the present field theories (without any change—such as that proposed by Dirac[2], or that by Born and Peng[3]) are sufficient to explain most of the known facts. For example, the anomalous value of the magnetic moment of the proton or the neutron can now be rigorously dealt with. It seems possible that the infinite self-energy of the point electron, which has always been a difficulty in the classical theory, will also become finite in the quantum theory.

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[1] Heitler and Peng, *Proc. Camb. Phil. Soc.*, **38**, 296 (1942).
[2] Dirac, *Proc. Roy. Soc.*, A, **180**, 1 (1942).
[3] Born and Peng, *Proc. Roy. Soc. Edinburgh*, A, **62**, 40 (1944).

## Interpretation of Patterson Diagrams

UNDER this title, Robertson[1] has published a simple optical method of constructing Patterson diagrams. Hägg[2] has suggested a modification of this method. Bragg[3] described a further improvement by the introduction of a lens in the path of the light rays, so that both patterns, the diagram of which is required, are on the same scale. The Patterson is then formed in the focal plane of the lens, and can be photographed, viewed on a screen or with the aid of an eyepiece. The whole arrangement then consists of an ordinary camera or telescope, in front of which are held two identical and properly oriented patterns. The scale of the Patterson can be varied by varying the distance in between the patterns. If the aperture of the lens is made large enough to accommodate all the relevant rays, the second screen need not be in contact with the lens. If punched screens are used, the only disadvantage is the lack of continuous adjustment of the pattern, possible in the original sphere and thread method of Robertson.

Very interesting arrangements are obtained if one of the patterns is replaced by an image of the other pattern in a plane mirror $M$ (Fig. 1). One pattern only is then necessary. The illumination can be obtained by means of a 45° glass plate $G$ (see Fig. 1$a$), in between the pattern and the objective $L$. If movable opaque disks are placed at $BB'$, black spots will appear on a bright background at $AA'$. The Patterson resulting from this arrangement at $CC'$ has unfortunately very poor contrast, peaks in the Patterson appearing as only slightly more luminous spots on an already luminous background. If an opaque sheet in which holes are punched is placed at $BB'$, bright spots on a dark background will appear at $AA'$, and the Patterson at $CC'$ would have luminous peaks on a black background, thus giving a very good contrast. However, the virtue of the continuous adjustment possible with disks is lost.

Another arrangement is represented in Fig. 1$b$. The atoms are here represented by disks, the upper surfaces of which are blackened, and the lower surfaces whitened. The white sides illuminated from below would appear at $AA'$ as bright spots on a black background, and the Patterson at $CC'$ would have peaks represented by darker spots on a bright background. This arrangement has the advantage of the continual adjustment, for example, by placing movable disks on a glass plate $P$.

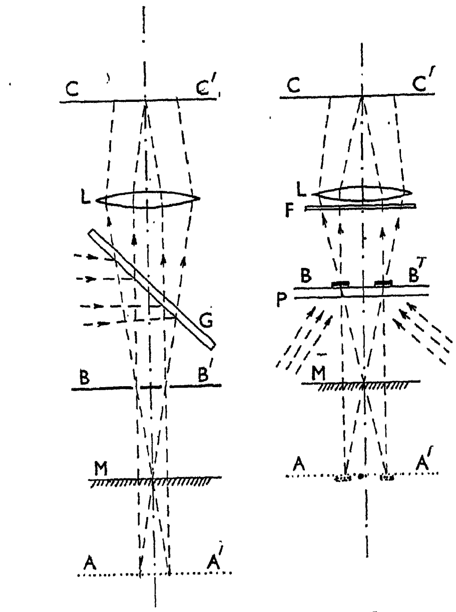


FIG. 1. THE CONSTRUCTION OF A PATTERSON DIAGRAM BY MEANS OF A MIRROR IMAGE. (a) ILLUMINATION BY 45° GLASS PLATE. (b) ILLUMINATION OF FLUORESCENT DISKS FROM BELOW.

In this method, the appearance of the Patterson is that of a negative of the pattern produced by a punched screen, the central peak being completely dark in the middle. This kind of pattern, although representing the Patterson function faithfully in terms of the difference of light intensities, is in some cases not so suitable for a direct visual examination as the positive pattern produced by the first method using a punched screen, due to the non-linear (logarithmic) response of the eye to the light intensity. However, if a photograph is taken, it is easy to examine either the positive or the negative, and both methods are equivalent in performance. In the second method, care must be taken to provide uniform illumination of the disks and at the same time to prevent the light from the light source entering the objective directly. This can be most conveniently overcome by using a mercury ultra-violet lamp with a Wood's glass filter for the illumination of the disks at $BB'$, and by painting the under sides of the disks with a yellow fluorescent paint. If a yellow filter $F$ is placed immediately in front of the objective, the direct radiation from the lamp will be cut off, and only the yellow light emitted by the disks would enter the objective. A contrast image is thus obtained.

Pattersons corresponding to two-dimensional multicellular structures are sometimes needed, whereas methods using continuous adjustment are practicable for the production of a Patterson of a single cell only. A Patterson of a multicellular structure can be easily obtained by superposition of a properly spaced double array of Pattersons of a single cell, the spacing in the array being equal to the lattice spacing of the original lattice. As the single-cell Patterson is twice the size of the original cell, the superposition of only four single-cell Pattersons would give in the central overlapping part all the informa-

tion needed. The superposition can be conveniently achieved photographically by successive exposures on the same plate.

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[1] *Nature*, 152, 411 (1943).
[2] *Nature*, 153, 81 (1944).
[3] *Nature*, 154, 69 (1944).

## Elastic Constants of Diamond

BY using a suitably cut and silvered quartz or tourmaline wedge, we have been able to generate continuously varying ultrasonic frequencies. This forms the basis of a new method for measuring the effective elastic constant of a given plate. In this method, the particular frequency for which there is best transmission through the plate is located by allowing the waves to pass through the plate into a liquid and observing positions of maximum intensity in respect of the usual Debye–Sears pattern. This frequency $\nu$ is related to the effective elastic constant $C'_{33}$ by the relation $4\nu^2d^2\rho = C'_{33}$, where $d$ and $\rho$ are respectively the thickness and the density of the plate.

By making such observations on an octahedral and a dodecahedral plate of diamond, two independent effective elastic constants have been obtained. It is not possible to get the third one by this method, but by combining the results with the known bulk modulus $5 \cdot 9 \times 10^{12}$ dynes per sq. cm. (which represents the mean of observations by Adams[1] and by Williamson[2]), the following values expressed in dynes per sq. cm. have been obtained for the elastic constants of diamond:

$C_{11} = 9 \cdot 4 \times 10^{12}$; $C_{12} = 4 \cdot 2 \times 10^{12}$; $C_{44} = 4 \cdot 2 \times 10^{12}$.

These results are now reported in view of their importance, but their significance will be discussed and the details of the method given in a fuller paper in the *Proceedings of the Indian Academy of Sciences*. It may be remarked here that we have found these elastic constants to be in satisfactory agreement with the force constants derived from the known frequencies of the diamond lattice.

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[1] *J. Wash. Acad. Sci.*, 11, 45 (1921).
[2] *J. Frank. Inst.*, 193, 491 (1922).

## A Reversible Contraction Phenomenon in Animal Hairs

ALTHOUGH the action of cuprammonium hydroxide on cellulose has been studied in considerable detail, comparatively little is known of its effect on keratin, except that under certain conditions hair and wool can be dissolved in the reagent[1,2]. It is therefore of interest to describe some observations on the action of cuprammonium hydroxide on wool which promise to yield valuable information on the mechanism of long-range elasticity in animal hairs and on the structure of proteins.

If a wool fibre (Lincoln) is immersed in a solution prepared by dissolving purified copper hydroxide in concentrated ammonia solution, it will, after a time depending on the copper content of the solution, become stained greenish-blue and contract in length. Prolonged washing in water fails to remove the stain and has little effect on the length, although a further small contraction may occur. Under the correct conditions it is possible to realize in this way a contraction of 28 per cent of the initial length. If the fibre is now placed in a dilute solution of sulphuric acid for a few minutes, the blue stain disappears and the fibre returns practically to its original length. Subsequent washing in water produces no further change in colour or length. The power of the fibre to recover its original length depends on the severity of the treatment; after prolonged immersion in concentrated solutions the recovery may stop when the fibre is still some 10 per cent shorter than the initial length. Even though the fibre retains its power of recovery, it is weakened by the treatment with cuprammonium hydroxide, and evidently side-chain breakdown takes place in the solution.

The dimensional changes are accompanied by changes in the X-ray photograph, which becomes weaker and vaguer without loss of orientation or pronounced spacing changes, until, when the contraction is a maximum, it has almost disappeared. This is in striking contrast to the effects in ordinary supercontraction, where the normal $\alpha$-photograph may still be present for contractions of the order of 20 per cent, although the disoriented $\beta$-photograph may appear under certain conditions[3]. After acid treatment to remove the copper, the $\alpha$-photograph returns, comparable in every way with the original photograph. This sequence can be repeated several times.

The coloration of the fibres after treatment with cuprammonium hydroxide and washing in water is clearly due to the adsorption of copper. Our measurements showed that the amount of copper adsorbed under conditions corresponding to those giving maximum contraction is about 29 per cent (by weight, calculated on the dry weight of the fibre), the observed values lying between 26 and 32 per cent for different concentrations of the reagent. This corresponds approximately to one copper atom per two amino-acid residues. The total increase in weight (40 per cent) suggests that the copper is present as a complex.

The observed contraction may be attributed to the powerful attraction of the copper for the appropriate active groups (for example, amino- and imino-groups) in the keratin complex. This contraction would be resisted by those side-chain cross-linkings between the polypeptide chains which are not broken by the reagent itself, and at first enough would be left stressed but unbroken to assure the return of the fibre to the initial length on removal of the copper. Prolongation of the treatment, however, would ultimately reduce the number of unbroken cross-linkings below the minimum required for complete recovery.

We have observed a similar phenomenon in fibres treated with solutions of some, but not all, related copper compounds.

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Sept. 11.

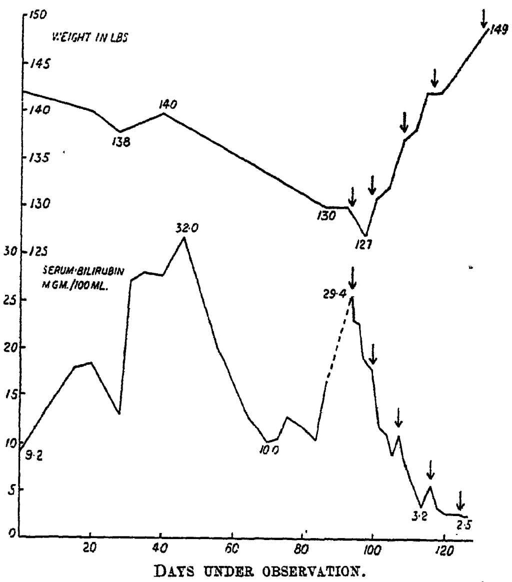
[1] Bergmann, M., D.R.P., 445,503.
[2] Rimington, C., and Wool Industries Research Association, *Brit. Pat.* 343,838.
[3] Astbury, W. T., and Woods, H. J., *Phil. Trans.*, A, 232, 333 (1933).

## The Sulphur-containing Amino Acids in Jaundice

We have read with interest the letter from Peters *et al.* on "The Sulphur-containing Amino Acids in Jaundice"[1]. The authors would appear to have misunderstood the statements made in our previous note[2] concerning the value of methionine treatment. We said only "that results would appear to show that the clinical course is influenced beneficially and the period in hospital significantly shortened". This statement is supported rather than contradicted by the data contained in their note, though statistical analysis of figures based only on serum bilirubin levels may not yield entirely reliable results. We would like to repeat our claim that "in *gravely ill* patients, the results obtained by methionine treatment have been so striking as to leave no doubt as to the efficacy of the treatment especially in those cases which have remained jaundiced for weeks or months". Such cases, we note, were not included by Peters *et al.* in the 150 cases selected by them for statistical analysis. They are, of course, not susceptible to statistical analysis, yet it is precisely in such cases, relatively uncommon though they are, that the clinical value of any special treatment can be most readily assessed. Moreover, it is in such cases which do not show the rapid and spontaneous recovery so typical of the ordinary jaundice case that some form of specific treatment is urgently required. The results obtained in such cases are best recorded by describing a typical example.

The patient was a young Canadian officer who was wounded in Italy in September 1943, transferred to North Africa for treatment and arrived in England in November. In December he developed a severe attack of infective hepatitis. Three months after the onset of the disease he was still icteric, in poor clinical condition and had lost 42 lb. in weight. Throughout this period he was anorexic, had frequent attacks of vomiting and was wasting steadily. In March 1944 he showed signs of an acute relapse and became gravely ill. He was transferred to one of our investigation wards for treatment. There was no suggestion of any cirrhotic change within the liver. Methionine was given intravenously in doses of 10 gm. on the first day he came under our care and on four subsequent occasions. After each infusion (indicated on the graph by an arrow), with the exception of the last which was given after the patient was obviously well and fit for discharge, the response was quite clear cut. Within twenty-four hours appetite improved and the liver receded, the serum bilirubin level fell sharply and four days later a marked gain in weight commenced (see graph). Occurring once, such a correlation between subjective symptoms, objective signs and therapeutic measures might well be coincidental. For this reason we withheld further methionine treatment until there was evidence of deterioration in his condition. It is probable that complete recovery would have been more rapid had methionine been given at shorter intervals. That recovery was eventually complete is suggested by the fact that a severe attack of hæmolytic streptococcal tonsillitis three weeks after discharge caused no apparent regression of his liver condition nor any rise in his serum bilirubin level. After discharge he continued to gain weight and reached his normal level within a few weeks.

We would make it clear that not all severely ill patients show such a gratifying response. Severe




cases may be broadly divided into three groups. In the first the illness is due to an apparently uncomplicated hepatitis. This may be long-standing, but is apparently unaccompanied by any marked degree of cirrhosis, and the response to methionine is good. In many chronic cases there is an acute hepatitis imposed on a pre-existing cirrhosis. Here there is a limited improvement the extent of which depends on the degree of cirrhotic change. A third group consists of those cases which have progressed to the stage of 'acute yellow atrophy'. The degree of hepatic autolysis is usually sufficient to produce a marked elevation of the blood amino nitrogen level. In such cases cellular destruction is so extensive that methionine is of no value.

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[1] *Nature*, 153, 773 (1944).
[2] *Nature*, 153, 525 (1944).

## Simultaneous Determination of Aneurin and Nicotinamide Methochloride

Nicotinamide methochloride, the principal urinary derivative of nicotinamide, nicotinic acid and nikethamide, can be estimated in urine by adsorption on 'Decalso', elution with potassium chloride and extraction of the eluate with alkaline *iso*butanol[1]. By this procedure the methochloride is converted into a whitish fluorescent derivative, $F_2$, the concentration of which is estimated fluorimetrically. Aneurin is also estimated in urine by adsorption with 'Decalso', elution with potassium chloride and extraction of the eluate with *iso*butanol after the addition of alkali and potassium ferricyanide[2]. The thiochrome thus formed is estimated fluorimetrically in much the same manner as that employed for $F_2$. It has been found, however, that pure aqueous solutions of nicotinamide methochloride are also converted into a deep blue fluorescent pigment closely resembling thiochrome by alkaline-ferricyanide-*iso*-

butanol treatment[3]. In other words, the methochloride may be converted into the whitish fluorescent pigment $F_2$ by alkali and *iso*butanol alone, or into a deep blue fluorescent pigment by alkali, *iso*butanol and ferricyanide.

Both the methochloride and aneurin are present in normal urine. Alkaline ferricyanide treatment of either the untreated urine or potassium chloride eluates from 'Decalso' columns will result in the formation of a mixture of two bluish fluorescent substances. One of these is thiochrome, the other an oxidized derivative of nicotinamide methochloride $F_3$ (probably an N-methyl α pyridone derivative of nicotinamide).

No procedure so far elaborated has succeeded in separating these two pigments. A preliminary *iso*butanol washing of the urine is of no avail since the non-fluorescent methochloride is insoluble in *iso*butanol; nor is any adequate blank correction possible since alkaline *iso*butanol treatment of the urine or potassium chloride eluate without the addition of ferricyanide converts the methochloride into the whitish fluorescent pigment $F_2$.

Some of the procedures in use to-day for the estimation of thiochrome involve the subtraction of the fluorescence of the $F_2$ (blank) from the combined fluorescence of $F_3$ and thiochrome. This necessarily introduces an error in the assay since Najjar and Ketron's[3] observation that the fluorescence of $F_2$ is much greater than the fluorescence of the $F_3$ has been confirmed.

We have observed that if known amounts of the methochloride are adsorbed on 'Decalso', eluted with potassium chloride and treated with alkali, ferricyanide and *iso*butanol in the manner employed for aneurin assays, it is possible to determine the 'aneurin equivalent' of the $F_3$ formed by comparing it with the thiochrome standards used for the aneurin determination. By assaying the methochloride content of urine (alkaline *iso*butanol treatment of the eluate without the addition of ferricyanide) the fluorescence of the alkali-ferricyanide treated extract which is due to $F_3$ can be computed.

A procedure has been devised which makes it possible to estimate aneurin in the presence of nicotinamide methochloride and to estimate accurately the methochloride content by means of fluorescence standards in place of the usual commercial fluorimeters. The method is applicable to urine or extracts from foods. 1 gm. portions of 'Decalso' are washed into thistle funnels with an internal bore of 4 mm. The adsorbant is activated according to the procedure of Hennessy and Cerecedo. Urine or food extracts are adjusted to $p$H 4·0 and filtered through the columns; these are then washed with 20 ml. of 1 per cent acetic acid and eluted with 8 ml. of 25 per cent potassium chloride. Half of each eluate is treated successively with 0·25 ml. 0·5 per cent potassium ferricyanide, 1 ml. 20 per cent caustic soda and 5 ml. *iso*butanol and then shaken for one minute. The fluorescence intensity of this extract which contains the $F_3$ and thiochrome is compared with thiochrome standards prepared from aneurin solutions treated in the same manner. 1 ml. caustic soda and 5 ml. *iso*butanol are added to the other half of the eluate which is also shaken for one minute and compared with $F_2$ standards prepared from pure nicotinamide methochloride. The fluorescence due to the $F_3$ is computed from the methochloride assay and subtracted from the total blue fluorescence due to $F_3$ and thiochrome.

Certain precautions must be observed to ensure a fair degree of accuracy. The 'Decalso' obtainable in Great Britain will not completely adsorb aneurin or nicotinamide methochloride from concentrated urine if the volume is more than 10 ml., regardless of the care taken in activating the adsorbant. The urine should be diluted to a volume equivalent to an excretion of 150 ml. per hr., and if 1–10 ml. of this diluted sample is taken for assay the adsorption will be complete. The average values of the assays of three different volumes of urine should be taken. The potassium chloride eluates obtained in urine assays are invariably non-fluorescent, which indicates that no pre-formed thiochrome is present in untreated urine. Although a great many highly fluorescent pigments are present in urine, they are either not adsorbed on 'Decalso', or if they are adsorbed they are not eluted with potassium chloride and therefore they do not interfere with the assay.

It has not been possible to estimate aneurin by this method with a consistent error of less than $\pm$ 10 per cent. The addition of large amounts of both aneurin and the methochloride to urine containing known amounts of these substances and the subsequent assay of the mixture have given good results. It is felt that some workers have claimed too high a degree of accuracy for the thiochrome method in the assay of natural products since different laboratories using the same method in the assay of identical samples have not obtained a high degree of concordance[4]. Our method gives reliable and reproducible values in the nicotinamide methochloride estimation, which show an error of $\pm$ 5 per cent. The precautions suggested by Wang and Harris[5] and others for the development of fluorescence in the aneurin assay must be observed. The fluorescence of the reagents used must also be rigidly controlled.

In view of the great dissimilarity of chemical constitution, it is surprising that the $F_3$ derivative of nicotinamide methochloride and thiochrome are so similar in fluorescent properties and chemical stability. The fluorescence of both can be decreased or completely destroyed by the addition of strong oxidizing or reducing agents, exposure to light or by strong alkali. For most urines the addition of 0·25 ml. 0·5 per cent potassium ferricyanide is sufficient to convert the methochloride into $F_3$ and the aneurin into thiochrome. The assay of urines from subjects who have ingested large amounts of aneurin or nicotinamide or both is best accomplished by the dilution of the urines. It is unwise to add more than 0·25 ml. of ferricyanide without first calibrating the amount needed for the oxidation.

The presence of nicotinamide methochloride in meat, liver and milk of animals which methylate nicotinamide has been detected; the methochloride appears to be absent from cereals. An assay of a complete diet, if one assumes complete extraction of the methochloride by the methods recommended for the aneurin extraction, has shown that the total intake of the methochloride is about 7 mgm. a day. This concentration is sufficient to cause an appreciable error in the aneurin assay if no correction is made for the presence of $F_3$. It would seem that the assay of nicotinic acid in animal products gives results which are too high, since the alkali hydrolysed extracts of the physiologically inactive methochloride give a positive cyanogen bromide reaction. The methochloride does not seem to promote the growth of *Lactobacillus arabinosis*[6]. Whether it is active for

other micro-organisms used for vitamin assay is not determined.

This work forms part of an investigation on nutritional deficiencies carried out on behalf of the Air Ministry under the direction of Wing-Cmdr. T. F. Macrae; the author is a member of the Civilian Technical Corps.

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[1] Coulson, R. A., Ellinger, P., and Holden, M., *Biochem. J.*, **38**, 150 (1944).
[2] Jansen, B. C. T., *Rec. trav. chim.*, **55**, 1046 (1936). Hennessy, D. J., and Cerecedo, L. R., *J. Amer. Chem. Soc.*, **61**, 179 (1939).
[3] Najjar, V. A., and Ketron, K. C., *J. Biol. Chem.*, **152**, 579 (1944).
[4] Report by the Vitamin $B_1$ Sub-Committee of the Accessory Food Factors Committee of the Medical Research Council and the Lister Institute, *Biochem. J.*, **37**, 433 (1943).
[5] Wang, Y. L., and Harris, L. J., *Biochem. J.*, **33**, 1356 (1939).
[6] Elvehjem, C. A., and Teply, L. J., *Chem. Rev.*, **33**, 185 (1943).

## Determination of Aneurin by the Thiochrome Method after its Uptake by Yeast

FOR the determination of aneurin there are both chemical and biological methods. Among the former the thiochrome method is the most outstanding[1]. The biological methods are very tedious, and the error involved is considerable. For routine analysis, which necessitates the rapid attainment of a reliable result, the thiochrome method is the only one at present available. It involves the oxidation of the aneurin in alkaline solution to the fluorescent substance thiochrome, the latter being extracted with *iso*butanol or amyl alcohol and determined in a fluorimeter. The aneurin often occurs to a large extent as phosphate esters, for example, cocarboxylase, the thiochrome derivatives of which are not soluble in *iso*butanol. The thiochrome method gives excellent results with pure aneurin solutions or, for example, extracts of compressed yeast. In the determination of aneurin in certain materials, however, such as cereal products (especially flours of high extraction, bran, etc.), urine, blood, milk or molasses, complications arise, since interfering substances are present which in the oxidized or unoxidized state have different fluorescent powers, or influence the oxidation of the aneurin itself to thiochrome. A number of modifications have already been described, which, however, to judge from the literature, are not altogether satisfactory.

These difficulties have been overcome by the following method which is based on the previous work of Sperber and Renvall[2] and Sperber[3], who have shown that aneurin is very readily taken up by baker's yeast, especially under aerobic conditions and in the presence of a substrate. It has been found in these investigations and in those of Westenbrink and co-workers[4] that the aneurin in yeast occurs almost exclusively as pyrophosphate ester (cocarboxylase). This, however, is split up when the yeast is boiled; consequently the aneurin in the boiled extract is principally in the free form. Our procedure consists in shaking the material the aneurin content of which is to be estimated with baker's yeast, and afterwards determining the aneurin content of the extract obtained by boiling the yeast. Interfering factors present in the substance do not pass into the yeast extract.

Our investigations have shown that the capacity of the yeast for taking up aneurin is very great. Under the conditions of our experiments 1 gm. of yeast took up 900–1,000 μgm. aneurin from flour extract in the course of one hour's shaking. The quantities of yeast necessary are therefore so small that allowance generally can be made for the aneurin content of the yeast itself by means of an average value (in our case c. 4·5 μgm./gm.). In general we shook 50–200 ml. flour extract, containing about 60–120 μgm. aneurin, for ninety minutes at 25° C. (water thermostat) in Fernbach flasks with 2 gm. compressed yeast. In the beginning our results proved to be too low, despite the fact that, after shaking, the substance no longer contained any aneurin. The explanation must be that the phosphatase, which during the heating of the yeast splits up the cocarboxylase and other phosphate esters to aneurin (see above), had been inactivated during the shaking.

In this connexion reference may be made to the investigations on the pyruvic acid metabolism in starved yeast and aerated yeast performed by Runnström and co-workers[5]. The metabolism of pyruvic acid added to a yeast suspension is strongly inhibited in such yeasts. The results of this work, which is to be resumed, made it probable that it is the decarboxylation of the pyruvic acid through the agency of the cocarboxylase that is affected by the starvation or aeration treatment. It is possible that in this case also the above-mentioned dephosphorylation of the cocarboxylase plays a decisive part.

Attempts to use 'Diastase Merck', which, according to Ritsert[6], contains sufficient phosphatase to split the cocarboxylase, gave results which were not fully satisfactory. When this method is employed, the yield of thiochrome from the oxidation of the aneurin is diminished. The procedure is, moreover, rather lengthy. We therefore tried to employ the phosphatase of the yeast, adding fresh yeast to the shaken material. This proved to be without effect. It proved possible, however, to dephosphorylate the cocarboxylase in the shaken yeast by adding cytolysed yeast to the previously boiled extract of the shaken yeast and reboiling. Repeated analyses of the same flour gave values with a standard deviation of 2·6 per cent.

Aneurin added to flour extract was recovered, and in the determination of a cocarboxylase preparation values were obtained which corresponded well with the results of Warburg determinations on the same material. The method of analysis described is also used for the estimation of aneurin in molasses and urine.

A detailed account of these investigations will be published elsewhere.

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[1] Jansen, B., *Rec. trav. chem.*, **55**, 1046 (1936).
[2] Sperber, E., and Renvell, S., *Biochem. Z.*, **310**, 160 (1941).
[3] Sperber, E., *Biochem. Z.*, **313**, 62 (1942).
[4] Westenbrink, H. K. G., van Dorp, D. A., Gruber, M., and Veldman, H., *Enzymologia*, **9**, 73 (1940).
[5] Runnström, J., and Marcuse, R., *Ark. f. Kemi*, **18A**, nr. 14 (Stockholm, 1944).
[6] Ritsert, K., *Klin. Wochenschrift*, 1371 (1939).

## Configuration and Antiplasmodial Activity

THE current view[1,2] that there is no relationship between optical activity (configuration) and antiplasmodial action in the Cinchona series does not appear to be fully justified.

Neither the configuration of the asymmetric centres at $C_3$ and $C_4$[3] nor the bridged structure of the quinuclidine skeleton in quinine[1] has an influence on its activity. This latter statement follows from the fact that niquine and niquidine are biologically active[2] and that the same is true of the (6-methoxy-quinolyl-4)-α-piperidyl-carbinol (II) of Ainley and King[4]. The part of the molecule which is crucial for our discussion is, therefore, $C_8$ and $C_9$.

Furthermore, the *l*-alkaloids (with respect to both $C_8$ and $C_9$) are, at least frequently, not significantly different in activity from *d*-bases. The quinine equivalents are for:

| | | | |
|---|---|---|---|
| *d-apo*-quinidine methyl ether | 1·0 | *l-α-iso*-quinine | 0·6 |
| niquidine | 1·5 | niquine | 0·9 |
| dihydro-niquidine | 1·1 | dihydro-niquine | 0·6 |
| dihydro-cupreine | 0·9 | dihydro-cupreidine | 0·7 |
| dihydro-quinine | 1·35 | dihydro-quinidine | 0·8 |
| *apo*-quinine | 1·0 | *apo*-quinidine | 0·4 |

Epimerization at $C_9$ alone, however, causes complete loss of activity[5], whatever the configuration of the active compound epimerized is. One is, therefore, led to the hypothesis that alkaloids with the same sign of partial rotation at $C_8$ and $C_9$ have antiplasmodial activity; those with different sign of rotation at these two centres are inactive[2,6].

The following two conclusions which can be drawn from these considerations appear to be borne out by experiment.

(*a*) The quinine equivalents of optical antipodes (with respect to $C_8$ and $C_9$ only) do not differ more than by a factor of 1·5–2. Examples:

| | |
|---|---|
| Quinine | Quinidine |
| dihydro-cupreine | dihydro-cupreidine |
| *epi*-$C_9$-dihydro-quinine | *epi*-$C_9$-dihydro-quinidine |
| *epi*-$C_9$-quinine | *epi*-$C_9$-quinidine, etc. |

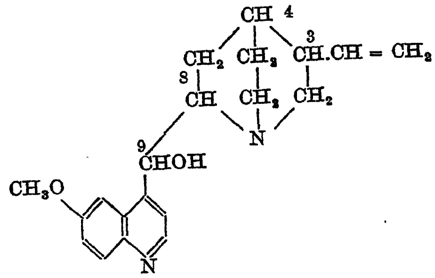
(*b*) The quinine equivalents of diastereomerides (with respect to $C_8$ and $C_9$ only) differ by a factor of 5–10. Examples:

| Alkaloid | Rotation at ($C_3$ + $C_4$) | $C_8$ | $C_9$ | Quinine equivalent |
|---|---|---|---|---|
| (1) Quinine | + | — | — | 1·0 |
| (2) *epi*-$C_9$-quinine | + | — | + | 0·1 |
| (3) Quinidine | + | + | + | 0·5 |
| (4) *epi*-$C_9$-quinidine | + | + | — | 0·1 |

(The pairs 1–2, 3–4, 1–4 and 2–3 are also diastereomerides.)

In view of these data, it is significant that the two isomers of Ainley and King's substance (II) have rather different antiplasmodial activity (the isomer of m.p. 162–163° about the same as quinine, that of m.p. 187–188° only 25 per cent of it). As, according to the synthesis, the two substances are diastereomides, one is tempted to suggest that the signs of rotation at the two asymmetric carbon atoms (which correspond to $C_8$ and $C_9$ in the quinine formula) are the same in the more active isomer of m.p. 162–163° and are different in the less active isomer of m.p. 187–188°. (Both of them are, of course, racemates.)

The somewhat unusual regularities which emerge from the accumulated experimental material seem to suggest that—in contradistinction with so many other biological effects—an optically active selective chemoceptor[7] is not responsible for antiplasmodial activity.



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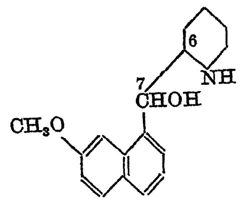

II

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[1] Goodman and Gilman, "The Pharmacological Basis of Therapeutics" 905 (New York, 1943).

[2] Buttle, Henry, Solomon, Trevan and Gibbs, *Biochem. J.*, **32**, 47 (1938).

[3] See Henry, Solomon and Gibbs, *J. Chem. Soc.*, 592 (1937), in conjunction with King and Palmer, *J. Chem. Soc.*, **121**, 2577 (1922).

[4] Ainley and King, *Proc. Roy. Soc.*, B, **125**, 60 (1938).

[5] Thron and Dirscherl, *Liebigs Ann.*, **521**, 48 (1935).

[6] Henry, *Chem. and Ind.*, **55** T, 111 (1936).

[7] Cushny, "Biological Relations of Optically Isomeric Substances" (Baltimore, 1926).

## Antibiotic Action of *Aspergillus fumigatus* against *Mycobacterium tuberculosis*

MANY papers have been published on the antagonism of certain micro-organisms against acid-fast bacteria, particularly *Mycobacterium tuberculosis*[1,2,3,4], recording varying results. I have tested during the past year various fungi for antagonism to acid-fast bacteria and have found *Aspergillus fumigatus* No. 367 of the National Collection of Type Culture to be the most effective.

Of the different media tested, Czapek-Dox medium with 2 per cent tryptone, 4 per cent brown sugar and 5 per cent glycerine yielded the best results. The active filtrate will be referred to as 'aspergillin'. The antibacterial power of the culture, which reaches its maximum in about 15–20 days, was determined by making serial dilutions of aspergillin in fresh broth with 5 per cent glycerine contained in 50 c.c. conical flasks, or 2-oz. flat medicine bottles. Then these were inoculated with a small amount (1–2 mgm.) of a young culture of acid-fast bacteria on glycerol broth or egg medium. In each test control cultures were also seeded. The cultures were incubated at 37° C.

The degree of growth in the various dilutions of aspergillin was compared with the growth on the control cultures at intervals of time. The final examinations of the cultures were made after 4–6 weeks in the case of *Mycobacterium tuberculosis* bovine and human type, with *Mycobacterium tuberculosis* avian type and *Mycobacterium phlei* after six days. For

the routine testing of activity *Mycobacterium phlei* was employed. *Mycobacterium tuberculosis* bovine, human and avian types were inhibited in the media containing 5–10 per cent, *Mycobacterium phlei* in the media containing 1–2 per cent of aspergillin. Two strains of Staphylococci tested were not inhibited. Judging from sub-culture tests, aspergillin seems to be bacteriostatic rather than bactericidal. It is not toxic to experimental animals in large doses and boiling for one hour does not destroy it. The next step is to purify this substance and then to test it as a chemotherapeutic drug against *Mycobacterium tuberculosis*, and to establish the possible relation or difference in the chemical and biological nature of other substances produced by *Aspergillus fumigatus*.

My thanks are due to Mr. C. A. McGaughey, acting director of this Institute, for laboratory facilities and his keen interest in the work and to Mr. M. O. J. McCarthy for the test of toxicity in the animals.

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[1] Vaudremer, A., *C.R. Soc. Biol.*, 73, 51 (1912); 74, 278, 752 (1913).
[2] Schiller, I., *Zbl. Bact. Abt. I. Orig.*, 96, 54 (1925); 103, 304 (1927).
[3] Barglowski, D., *Amer Rev. Tub.*, 38, 393 (1938).
[4] Zorzoli, G., *Amer. Inst. Carlo Forlanini*, 4, 208, 221 (1940); abstr. *Vet. Bull.*, 11, 833 (1941).

## A Powerful Inhibitory Substance produced by Group *N* Streptococci

IN 1933[1] Whitehead and Riddet, in New Zealand, observed that bulk milk stored overnight in cheese factories sometimes inhibited the growth of the 'starter' culture added to develop the acidity necessary for the cheese-making process.

From the stored milk Whitehead isolated a streptococcus and showed that it produced an inhibitory substance which he considered to be of protein or polypeptide nature[2]. Similar strains have been isolated from milk and starter by others[3,4], and those we have used in our work have been found to fall into Group *N*[5]. The inhibitory substance appeared to be powerful and it occurred to one of us that pathogenic organisms, in particular Group *B* streptococci causing bovine mastitis, might be similarly inhibited.

We have found that many groups of pathogenic streptococci are in fact inhibited even in media containing high proportions of serum or blood. Some species of Bacillus, Clostridium and Lactobacilli are also inhibited but staphylococci so far tested are less susceptible. All Gram-negative organisms so far tested were unaffected.

Since the substance proved to have marked inhibitory properties *in vitro*, preliminary attempts to concentrate it by chemical means were made. A product of high potency was obtained and a serial dilution technique used to assay it.

It completely inhibited the growth of the test organism (*Str. agalactiæ*) in a dilution of 1/640,000, and partial inhibition was observed at 1/1,000,000. The percentage of active substance in this product is, we know, small, so that these dilutions underestimate the activity of the prime inhibitory substance.

Using this impure material in a small preliminary mouse protection experiment, it was found that a single intravenous dose of 2 mgm. following inoculation with about 1,000 lethal doses of a mouse virulent hæmolytic streptococcus had marked therapeutic properties.

A further experiment using twenty control and twenty treated mice was therefore carried out. Each mouse in each group received about 10,000 lethal doses of the streptococcus used in the preliminary experiment, the virulence of which had been raised by animal passage. The untreated control group all died within twenty-four hours. Each mouse in the treated group received, subcutaneously, a total weight of 10 mgm. of the inhibitory substance in three-hourly doses spread over forty-five hours. All the animals were alive and active at the end of this time, when treatment ceased. At the end of seven days from the beginning of the treatment 40 per cent were apparently completely cured. Little or no local or general reaction was observed and toxicity tests with guinea pigs receiving 10 mgm. of the substance in a single dose were completely negative.

The product appears to have certain properties desirable in an inhibitory substance of biological origin. The crude preparation, at least, is heat-stable. The substance is produced in a simple broth medium, and pure culture on a large scale is not difficult. Strains of high potency are easy to select and appear to be stable for months at least.

Even the crude substance is well tolerated on subcutaneous and intravenous injection in distilled water solution. It is dialysable and is therefore a comparatively small molecule. Experiments in purification and application are continuing.

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[1] Whitehead, H. R., and Riddet, W., *N.Z. J. Agric.*, 46, 225 (1933).
[2] Whitehead, H. R., *Biochem. J.*, 27, 1793 (1933).
[3] Meanwell, L. J., *Proc. Soc. Agric. Bact.* (1943).
[4] Nichols, A. A., private communication (1944).
[5] Shattock, P. M. F., and Mattick, A. T. R., *J. Hyg.*, 43, 173 (1943).

## A Case of Choline Poisoning in Cattle

IN cattle at Kiriat Anavim (Palestine) the following pathological symptoms were observed. After the first calving the uterus did not contract but remained open and atonic for a considerable time, thus forming a source of secondary infections. This condition, which could not be influenced by the usual medical treatment, resulted frequently in inability to conceive and in abortions. No primary infectious disease could be found nor did anatomical or histological examinations of the sexual organs yield any result. The foodstuffs given were the same as employed usually in Palestine dairy farming. They were not deficient in nutrients, minerals and vitamins. The only unusual foodstuffs given were wet brewer's grains, which formed a considerable part of the rations for some years. Infected barley is known to have had detrimental effects in some cases, owing to an excessive content of amines[1], especially free choline[2]. Since normal barley generally does not contain appreciable amounts of free choline, we undertook to compare the brewer's grains with normal barley in respect to their choline contents.

The choline was obtained by extracting the materials with 60 per cent alcohol, and, after evaporation of the alcohol, removing the proteins, salts and other

impurities and precipitating the choline as the $HgCl_2$ compound. The choline was determined quantitatively as the reineckate[3]. Analyses of the $HgCl_2$ compound and of the reineckate confirmed the identity of choline. The amounts extracted were 20·0 kgm. fresh brewer's grains (containing 22 per cent dry matter) and 2 kgm. dry barley. Brewer's grains yielded 0·25–0·28 per cent choline (calculated as dry matter), whereas normal barley contained *no free choline*. A yield of 0·17 per cent choline was obtained only after saponification with barium hydroxide.

These findings seem to justify the conclusion that free choline can act as a poisoning agent when fed over long periods of time.

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Rehovoth.
Aug. 31.

[1] Hoyman, W. G., *Phytopath.*, **31**, 871 (1941).
[2] Schroeter, G., and Strassberger, L., *Biochem. Z.*, **232**, 452 (1931).
[3] Engel, R. W., *J. Biol. Chem.*, **144**, 701 (1942); *J. Nutrit.*, **25**, 441 (1943).

## A Possible Gene Duplication in New Zealand Romney Sheep

THE mode of inheritance in New Zealand Romneys of the N-type birthcoat, in which there is very high abundance of halo-hairs on the main area of the body, has been shown to be simple in three stocks of sheep[1,2]. In two stocks of independent origin N-type is a simple dominant to non-N. In the third, which is related to one of the dominant stocks through a common ancestor, the breeding experiments of the last two seasons have given further proof that N-type is a simple recessive to non-N. In addition, a small inbred N-type flock in which the mode of inheritance is multifactorial has been gradually but rapidly built up by selection.

Nearly all N-type rams, of whatever stock, are horned. It was formerly thought that in dominant-N sheep horns were conditioned by a sex-influenced factor linked with the factor for N-type with about 10 per cent crossing-over. It is now better to regard horns as a usual expression in males of any genetic make-up which gives an N-type birthcoat. In females the breeding results point to homozygous dominant-N animals ordinarily having horns, which are much smaller than most rams' horns. Occasional heterozygous dominant-N ewes are horned or have scurs or buttons, the latter being hard projections which do not pierce the skin. Recessive-N ewes have so far all been polled. So have most multifactorial-N ewes, but a few have horns, and several have scurs or buttons.

The central problem in genetic analysis is the relation between dominant-N and recessive-N. In developing earlier ideas, as two more crops of lambs have been born, emphasis is put the more on duplication, and it no longer seems helpful to think in terms of a dominigene or a suppressing factor. The present hypothesis is simply that the dominant factor for N-type is a duplication of the recessive gene for N-type. There is a substantial chance that in the experimental stocks the recessive gene has been duplicated on one or more occasions, and that the supposed dominant duplication has, once or a few times, been halved to give a germ cell possessing the recessive gene. The grounds for thinking that these things happen are not yet conclusive, and the main purpose of the breeding experiments has become to test the hypothesis that has been stated. We must ascertain whether dominant-N, non-N and recessive-N are multiple alleles, and must give more lambs suggestive of unequal crossing-over or the halving of a duplication the chance to be born.

If such crossing-over does indeed take place the data suggest its frequency to be nearer 1 in 100 than 1 in 10 to any other power. For an event that one thinks of as a rare abnormality this frequency seems high, but that it can happen so often is believable in the light of Drosophila work[3,4,5]. If a duplication were advantageous to the live-stock breeder, and took place with a frequency of this order, it would be worth while for him to watch for it. Moreover, the recent work on Drosophila, following the discovery that 'bar' is a duplication, suggests that this phenomenon is more than an out-of-the-way oddity. In the mouse, too, duplication may well be involved in the work of Dunn and Caspari[6]. Without the Drosophila work the present hypothesis seeking to explain sheep-breeding results would assuredly not have been put forward. Problems of selection in slow-breeding animals being so difficult, it is tempting to speculate on the possible significance for live-stock breeding of the duplication of a gene which thereby becomes in some way more powerful.

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Palmerston North,
New Zealand.
June 5.

[1] Dry, McMahon and Sutherland, *Nature*, **145**, 390 (1940).
[2] Dry and Sutherland, *Nature*, **148**, 563 (1941).
[3] Demerec and Hoover, *Genetics*, **24**, 271 (1939).
[4] Lewis, *Proc. U.S. Nat. Acad. Sci.*, **27**, 31 (1941).
[5] Oliver, *Proc. U.S. Nat. Acad. Sci.*, **26**, 452 (1940).
[6] Dunn and Caspari, *Proc. U.S. Nat. Acad. Sci.*, **28**, 205 (1942).

## The Commutation of Annual Subscriptions

I WAS interested in Dr. David Heron's letter in *Nature* of September 23, p. 400. The Royal Aeronautical Society allows compounding of annual subscriptions after payment of the entrance fee and first annual subscription, as follows: fellows, 12 years subscriptions; associate fellows and other grades, 15 years subscriptions. The amounts are reduced by one guinea a year for each year of membership after five years. The minimum ages for fellows is twenty-eight and associate fellows twenty-five. An additional compounding fee is payable on transference from associate fellow to fellow if the former has already compounded his subscriptions, on a *pro rata* basis of annual subscriptions. The whole of the entrance fees and life compositions are invested in an endowment fund, the interest only of which is available to the Society's funds. It will be noticed that the composition fee is irrespective of age. An associate fellow elected at twenty-five can compound for fifteen years subscription, while one elected at thirty-five will still have to pay the same composition fee. The fees were adopted on the advice of the Society's honorary accountant.

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# RESEARCH ITEMS

## Management of Small Artificial Lakes

GEORGE W. BENNETT gives a "Summary of Fisheries Investigations, 1938–1942" on this subject (*Bull. Illinois Nat. Hist. Surv.*, 22; 1943). The primary objective of fish management is to produce and maintain good fishing. The author defines 'good fishing' as including the element of numbers of fish caught for unit of time or effort, as well as that of size of individual fish. There is much to be done in maintaining these small artificial lakes, and this report gives a valuable summary of researches. The best fishes for these Illinois artificial lakes are large-mouth bass *Huro salmoides*, white and black crappies *Pomoxis nigro-maculatus*, bluegills *Lepomis macrochirus* and black and yellow bullheads *Ameiurus natalis natalis*. Other fish are apparently of little value in hook-and-line fishing. The chief causes for poor fishing are past improper stocking, large population of rough fish or other fishes of little use for angling, and stunting as a result of over-population. Lakes should be cropped in order to produce and maintain good yields. A cropping plan should include measures to control the numbers of fish of small size as well as the total poundage of large fish taken by anglers. Simple combinations of fishes tested to determine their value for angling shows the bass-bluegill combination to be one of the most satisfactory.

## Individual Variability of Micro-organisms

INTENSIVE studies in the polymorphism of cells of *Saccharomyces cerevisiæ*, carried out for 70–80 successive generations by N. A. Krasilnikov (*J. Gen. Biol.*, Moscow, 4; 1943), suggested a definite connexion between the individual variation and the formation of stable strains. It was established that the individual characters of each variation type are transmitted to the progeny, but with unequal degrees of persistency. In some cases, certain characters may persist through tens, and even hundreds, of generations; in others they do not extend beyond the third generation; and sometimes such individual characters are not inherited at all. Polymorphism tends to increase with the age of a culture and individual variants gradually become stabilized. The new strains formed in this manner are not reversible, but their eventual fate in the culture depends on the outcome of the competition with the initial strains from which they had split off; this fate is influenced by the nutrient medium being more favourable to one of the competing strains.

## The Tetrapod Middle Ear

THE study of new material of the hyomandibular and its relationships to the auditory and occipital regions of the skull in *Eusthenopteron*, a member of the rhipidostian crossopterygian fishes, has enabled T. S. Westoll (*Trans. Roy. Soc.*, B, 131; 1943) to give a more complete and accurate account than was furnished previously by Sternberg, who had only badly crushed material at his disposal. With this as a basis, Westoll proceeds to examine the general question of the tetrapod middle ear. The hyomandibular, he agrees, in conformity with a theory that has been suggested previously, becomes transformed into the stapes and its processus opercularis becomes the extracolumella. The development of a freely movable neck articulation early in the tetrapod stock resulted in considerable modifications of the hyobranchial apparatus, and further changes ensued with the transfer of the bones at the posterior end of the lower jaw in the reptiles. The homology of the tympanic cavity and membrane throughout the series has been denied by some authorities; but the author holds that from a primitive, dorsally situated tympanic diverticulum exemplified in the anuran amphibia arose a ventral, infra-stapedial recess in many reptiles and a further, more ventral mandibular recess in the theromorph reptiles, so that the whole form a homologous series the primitive parts of which are reduced in the mammals.

## Carbon Dioxide Metabolism in Insects

ACCORDING to current views, the blood of insects has no respiratory function, gaseous metabolism being carried out through the tracheal system, the organism getting rid of carbon dioxide not only directly through the tracheæ but also by the diffusion of carbon dioxide through the tissues. Under these conditions, any tendency of carbon dioxide to hydration, that is, to conversion into $H_2CO_3$ and $HCO_3$, would be hampering the elimination of carbon dioxide from the organism. Investigations by Kreps and Chenikayeva on the blood of orthopterous insects (*Bull Acad. Sci. U.R.S.S.*, No. 5; 1942) have shown that no carbonic anhydrase could be detected in it. In fact, it was discovered that the blood has a pronounced inhibitory effect on the hydration reaction of carbon dioxide. The inhibition factor contained in the blood is thermostable, withstands intensive boiling, is insensitive to poisons (for example, cyanide, sodium azide, etc.), prevents enzyme action, and is not bound to proteins. It is suggested that the inhibitor is not an enzyme. The biological significance of the inhibitor consists, presumably, in preventing hydration of the highly diffusible carbon dioxide to the slowly diffusible $H_2CO_3$ and $HCO_3$. The inhibitor, therefore, appears to form an essential feature of tracheal respiration.

## Pairing of Sex Chromosomes

GENETIC crossing-over between the sex chromosomes in the male of *Drosophila pseudoobscura* is rare or probably does not occur, yet these chromosomes are conjoined over part of their length during the diakinesis-anaphase period of meiosis; conversely, autosomes pair normally and genetic crossing-over occurs. In Darlington's chiasma hypothesis of metaphase pairing, chiasmata provide the primary, if not only, means of conjunction of chromosomes as bivalents. It is therefore assumed that the sex chromosomes in the male of *Drosophila pseudoobscura* are held together by chiasmata which are reciprocal and confined to inert regions of the chromosomes. K. W. Cooper has followed meiosis in the male of another fly, *Olfersia bisulcata*, which shows apparently similar phenomena (*Proc. U.S. Nat. Acad. Sci.*, 30, 50; 1944). In this type the sex chromosomes of the male do not pair until after condensation and then form the *X–Y* bivalent by means of approximation of localized pairing segments, which presumably do not form chiasmata. From observations by Darlington on *Drosophila pseudoobscura* it seems not improbable that here also the *X–Y* bivalents may be the result of late pairing during or after condensation. Such cases of delayed pairing are not unique among

insects. The full significance of the observation is not clear but suggests that bivalent formation in *Drosophila pseudoobscura* would repay closer analysis and that the chiasma hypothesis of metaphase pairing may not be capable of covering all the facts.

### Incompatibility in Tetraploid Clover

RECENT papers have given evidence of peculiar reactions of the incompatibility factors causing self- and cross-fertility in polyploids as compared with diploids. S. S. Atwood (*Proc. U.S. Nat. Acad. Sci.*, **30**, 69; 1944) has confirmed the behaviour of diploid and tetraploid clones of *Trifolium repens* in this respect. Two diploid plants, $S_1S_2$ and $S_3S_4$, gave rise after colchicine treatment to tetraploids. These tetraploids were self-incompatible, thus differing from results in *Petunia violacea* and *Oenothera organensis*. $F_1$ from the tetraploids were obtained with differing genotypes. By backcrossing and reciprocal crossing, the author shows that when only one type of heterozygous pollen is produced the presence of one or both factors in the style will inhibit growth; and that when several types of heterozygous pollen are produced none is inhibited in the pistil although there may be a similar factor in the style. It seems apparent that sometimes pollen growth depends on the total interaction of the pollen and style and not on a specific oppositional effect between one type of pollen and the style. Further evidence of this nature would be valuable in shedding light on the mechanism of inhibition of pollen tube growth.

### Hornlessness in Goats

S. A. ASDELL (*Science*, **99**; Feb. 11, 1944) suggests that the craze for selecting hornless goats has increased the percentage of intersexual animals. He has examined about three hundred animals which were intersexual and found that in every case they were hornless. He believes that intersexual goats are all females modified by a recessive gene which may be closely linked with hornlessness.

### Contamination of Porcelain Insulators

ACCORDING to W. G. Thompson (*J. Inst. Elec. Eng.*, **91**, Pt. 2, No. 22; August 1944) in a paper on the mechanism of contamination, an analysis of the nature of the air-borne particles forming the main source of contamination on outdoor porcelain insulators, and of the forces acting upon them in the electrostatic field around an insulator, suggests that these forces are inadequate to account completely for the observed distribution and the quantity of the deposits. Direct measurements of the field-strengths close to the insulator confirm that the voltage gradients do not reach very high values in normal conditions, and that the electrical forces are proportionately weak. Investigations of the air flow over the insulators, and comparisons of the formations of air eddies observed in the flow over the geometrical forms associated with the complex shapes of insulators, show that the aerodynamic conditions have a considerable bearing upon the patterns formed by the deposits on the insulators. Wind-tunnel experiments provide results which illustrate the influence of the Reynolds' number, the applied voltage, the surface roughness, the wind velocity and the humidity upon the distribution and amount of deposited matter. Moisture films constitute a special case of temporary contamination, with sparking following the receding edges of the drying films. Finally, a method is suggested of estimating the flashover values of insulators from a consideration of the distribution of surface resistance as modified by the presence of deposited matter. In the final determination of insulator performance from the anti-dirt point of view, it is essential to have recourse to the test racks of the testing stations and the manufacturers' laboratories, and to supplement the evidence obtained by service experience on overhead lines. The complete account must involve a study of the means by which material deposited on insulators is removed by wind, rain and frost, but there seems little object in attempting a study of this nature using only artificial deposits.

### Continuous Absorption Coefficient of the Negative Hydrogen Ion

RECENT attempts to find the source of the continuous opacity in stellar atmospheres, though they have strongly suggested that the negative hydrogen ion is responsible for much of the absorption, have resulted in only qualitative agreement between theory and observation. The quantitative breakdown of the theory in the visual region of the spectrum was traced a year ago by Chandrasekhar and Krogdahl to the use of a wave function of the ground-state of $H^-$ which was not sufficiently accurate at distances of the order of five times the Bohr radius. Henrich has now computed new absorption coefficients (*Astrophys. J.*, **99**, 59; 1944) using an eleventh-order Hylleraas type of wave function (third- and sixth-order functions had been used previously), and finds that the absorption reaches a maximum at 7500 A., which is 30 per cent higher than the previous maximum, which occurred at 4750 A. This modification considerably reduces the discrepancy between theory and observation in the relation between effective temperature and colour temperature in the visual region of stellar spectra, and establishes on a firm basis the hypothesis that the negative hydrogen ion is an important contributor to opacity in stellar atmospheres.

### Perturbations of Plato

IN *Observatorio Astronómico De La Universidad Nacional De La Plata*, **17**, 1941, Reynaldo P. Cesco, has a paper with the title "Perturbaciones Seculares De Plutón". Owing to the close approach of the orbits of Pluto and Neptune, difficulties arise about the application of the Gaussian method which, in such circumstances, is unsatisfactory. The author attacks the problem by developing $1/\Delta$ in powers of $e$, $e'$, and $\eta^2$, in a manner similar to the Laplace-Le Verrier method, but amplified by the use of certain corrections developed by Boquet. It is shown that the series converges even under the most unfavourable conditions for the two planets under consideration. The second chapter gives the formulæ for computing the coefficients and their derivatives, first for a definite value of the mutual inclination of the orbits, and then for the general case. In Chapter 3, reverting to the representation of the perturbative function and its derivatives by double integrals, by means of a convenient application of the theory of approximations by polynomials, a method for computing secular perturbations is developed. This method is sufficiently accurate, at least in the first approximation with respect to the mass. It is very suitable for Pluto and Neptune and its application to these planets is shown in Chapter 4.

# RADIO AND ELECTRICAL ENGINEERS

THE application of electricity to signalling along wires in the latter half of the nineteenth century led to the foundation in 1871 of the Society of Telegraph Engineers. At a later date the title was changed to the Institution of Electrical Engineers and its scope expanded to enable it to cater for the interests of all those professionally engaged in electrical engineering in Great Britain. Moving with the growth and development of wireless telegraphy and telephony, the Institution inaugurated in 1919 a Wireless Section to deal with the subjects of high-frequency engineering and audio-frequency recording and reproduction. Shortly afterwards, the Institution was incorporated by Royal Charter, and the fully qualified members were granted the right to describe themselves as chartered electrical engineers. At the same time, it was recognized that, while maintaining the standard of the qualifications for membership, more opportunity should be afforded to the physicist engaged in radio work to become a member. It is particularly opportune to direct attention to this fact at the present time, when a large number of men engaged in scientific and technical radio work would probably describe themselves as radio physicists rather than as wireless or radio engineers. The Institution thus welcomes as potential members those who, although not having received the usual training of electrical engineers, nevertheless hold degrees or equivalent qualifications in physics and are fully expert in their own branch of radio technique. It is perhaps significant of the times to point out that for the past three years the president of the Institution of Electrical Engineers has been a member whose main professional interest has been in the field of telecommunications, the present holder of that office being Sir A. Stanley Angwin, engineer-in-chief of the Post Office.

On May 3 last, the Wireless Section of the Institution held a special meeting to commemorate the silver jubilee of its formation in 1919, and six past chairmen of the Section delivered short addresses which have now been published (*J. Inst. Elect. Eng.*, 91, Part III, No. 15, September 1944). After an introductory address by the president, Dr. W. H. Eccles gave a short account of the technical events in the early progress of wireless communication which led to the formation of the Wireless Section. Prof. G. W. O. Howe followed with a survey of the development of the principles and theory of the subject, with special reference to the properties of the ionosphere. The early development of wireless telegraphy in the Navy from 1899 onwards was dealt with by Admiral Sir Charles E. Kennedy-Purvis, who referred to the fact that the close co-operation between the Navy and the General Post Office has from the beginning been a characteristic feature in wireless progress in Britain. The life of the Wireless Section of the Institution of Electrical Engineers has coincided with the growth of practical wireless telephony, for it was in 1919 that the early experiments in the transmission of speech and music took place in Great Britain and paved the way for the development of broadcasting. Starting from this point, Mr. H. Bishop traced the history of the British Broadcasting Corporation and its activities in providing a British and Empire broadcasting service. He also referred to the growth of television, in which field, prior to the present War, Great Britain held a decisive lead over all others, including the United States of America. Finally, Dr. R. L. Smith-Rose attempted to portray what the future might have in store when the greatly increased knowledge and experience gained during the War becomes available for application to peace-time requirements. The whole field of radio communication and navigation, and of aural and visual broadcasting would make rapid and important advances; and Dr. Smith-Rose looked forward to the day when radio-controlled pilotless freight-carrying aircraft would fly distances comparable with that of the North Atlantic route between Great Britain and North America. Reference was also made to the heavy debt which all the applications and advances that were mentioned by the various speakers at the meeting owe to those patient investigators and research workers, who in recent years have laid the foundations and established the essential facts which form the basis of all development work.

Since the jubilee meeting just referred to, the Council of the Institution of Electrical Engineers has decided to change the name of the Section from "Wireless" to "Radio", and to extend its scope to cover the field generally known nowadays as "electronics". In this way the Institution has shown itself fully alive to the progress of the art and science of radio technique, and to the necessity of keeping this Section virile and up-to-date, and capable of representing the best interests of those engaged in the radio profession.

The chairman of this Radio Section for the current year is Mr. H. L. Kirke, head of the Research Department of the B.B.C.; and on October 11 he delivered his inaugural address to the Section, the members of which now number about two thousand. In the first portion of his address, Mr. Kirke referred to the fact that it has been felt for some time that there ought to be closer co-operation with the Institute of Radio Engineers of America. War conditions made a definite move rather difficult, and it was clear that the matter needed oral discussion. An opportunity for this occurred early this year, when both Mr. Kirke and Dr. Smith-Rose, a past chairman of the Radio Section, were in the United States; they were invited, together with Mr. F. S. Barton, also a member of the Section and recently a vice-president of the American body, to attend a meeting of the Board of Directors of the Institute of Radio Engineers in New York. At this meeting a number of proposals were discussed and very well received; and in order to put these into effect, a special Liaison Committee has been formed in Great Britain to work with a similar committee in the United States. Thus a close link has been forged between the Radio Section of the Institution of Electrical Engineers in Great Britain and the Institute of Radio Engineers in the United States; and it is hoped that, as a result, there will be a freer interchange between the two bodies of papers, discussions and other matters of mutual interest.

In the second part of his address, Mr. Kirke dealt with the subject of impedance measurement at radio frequencies. There has been considerable development in this field over the past decade. Mr. Kirke described, with the aid of diagrams and photographs and an exhibition of the apparatus, five types of radio-frequency bridge which have been developed and used during the past ten years: reference was also made to the associated apparatus and to a low-

frequency capacitance bridge which was the forerunner of some of the radio-frequency equipment. Those interested in this type of apparatus technique will look forward to the publication of the address in the *Proceedings* of the Radio Section of the Institution.

## GEOLOGICAL SERVICE OF THE U.S.S.R.

THE Soviet Geological Service is working hard on problems connected with the defence of the country, the development of industry and the rehabilitation of the national economy of the liberated regions.

I. I. Malyshev, the chairman of the Geology Committee of the Council of People's Commissars, states that this year Soviet geologists are concentrating on a search for new mineral deposits. The Committee has already sent out more than six hundred parties of geologists and experts for field work.

Newer methods of work have been adopted, among which is the use of geophysical instruments which reveal the magnetic, gravitational, seismic and other features of rocks. The employment of these methods in past years has led to a number of discoveries being made. For example, an aeromagnetic survey of Western Siberia led to the discovery of new iron ore deposits.

This year's prospecting is mainly to find new deposits of molybdenum, tungsten, tin, mercury, mica, etc. Great importance is placed on these surveys as increased quantities of raw materials are needed for the iron and steel mills now being built in Siberia, Kazakhstan and other parts of the country.

It is hoped soon to complete the work on composite hydrogeological maps of the industrially and economically important regions of the U.S.S.R. These maps will show sub-soil waters, their quality, the conditions under which they are found, and the possibility of their being used for industry, transport, agriculture, and the water supply of inhabited centres. This information is valuable in planning the economic development of the districts concerned. In compiling these maps, data obtained by specially organized hydrogeological expeditions were added to the mass of available geological material. An example of the importance of the work done in the realm of hydrogeology is the discovery last year of deposits of fresh, sub-soil water at an accessible depth in the seemingly waterless Kara Kum desert.

All work and expeditions of this nature are under the direction of the All-Union Research Institute for Hydrogeology and Engineering Geology. The All-Union Commission on Mineral Deposits will this year confirm the estimate of coal supplies available to all enterprises in the coal-mining industry; and the same will be done for the oil industry.

The scope of the State Geological Survey has been increased by almost 50 per cent this year. The Survey will give a complete picture of the geological structure of the U.S.S.R. and provide the foundation for all future prospecting and survey work. Aerial photographs are extensively used for this work.

Another important institution is the All-Union Geological Records which collects material on all the geological work done on Soviet territory. This year it is compiling a sort of encyclopædia of all known mineral deposits of the U.S.S.R. which will run into about 16,000 printed pages.

Soviet geologists are also busy at the front. Special detachments of geologists are working on all sectors of the front providing geological data for the advancing Red Army.

They supply the staff with necessary information when the Red Army has to force water-courses, pointing out places through which tanks can pass, help in organizing the army's water supply, search for building materials for dug-outs, roads and bridges, and give advice regarding camouflage. This work is frequently carried out under enemy fire. The selfless work of many geologists at the front has been marked by the award of Government decorations.

## ECONOMY IN THE USE OF DRUGS

THE first edition of the Medical Research Council's War Memorandum No. 3, entitled "Economy in the Use of Drugs in War-time", was issued in March 1941. It represented the views of the Council's Therapeutic Requirements Committee and a first Supplement to it was issued in November 1941. A second revised edition is now issued (H.M. Stationery Office, 1944. 3*d*.). It includes an appendix on economy in the use of bactericides and disinfectants, large quantities of which are, the appendix says, used in hospitals and private practice under conditions in which they are not likely to be effective. Sterilization by heat is always preferable to the use of disinfectants and should be used if possible. Mercurial disinfectants have to be imported, and mercury is required for munitions, so that the indigenous coal-tar disinfectants should be used as much as possible. The same Council's War Memorandum No. 6 on "Prevention of 'Hospital Infection' of Wounds" contains recommendations for the use of disinfectants of the phenolic type.

An appendix to the first edition of the Memorandum described the production of drugs in the British Empire, but "the activities arising in this connection" have since been assumed by the Vegetable Drugs Committee set up by the Minister of Health. This Committee now works within the organization of the Ministry of Supply. Responsibility for the provision of drugs and therapeutic substances is now vested in the Ministry of Supply, which acts in consultation with the Ministry of Health, and both Ministries are represented on the Therapeutic Requirements Committee. Difficulties in obtaining supplies of important drugs should be referred to the Directorate of Medical Supplies, Ministry of Supply, Portland House, Tothill Street, London, S.W.1.

This second edition of the Memorandum revises and extends the lists given in the first edition. It adds many new items and incorporates the first Supplement. Further, the method of classifying the substances listed has been changed. In the first edition Class *A* brought together drugs which were regarded as essential and those which were readily available without indicating which of these reasons determined the inclusion of particular drugs in this Class. At the time of publication it was undesirable to publish this information. It has, however, become increasingly difficult to keep separate the ideas that a drug may be on one hand readily available and on the other essential. Too rigid a classification may defeat its own object unless there is a rigid scheme of rationing,

which has not yet been necessary. In any event no drug can be regarded to-day as being freely available, and economy is necessary in the use of all drugs. This second edition of the Memorandum has therefore classified substances into *A*, drugs which are important therapeutic agents and which should be made available so far as is possible; *B*, drugs which are needed for certain purposes, but supplies of them are limited—it is left to the good sense of the prescriber to use these only for purposes for which they are known to be valuable; alternatives to them are indicated, whenever this is possible; *C*, drugs which are not essential and do not justify importation or manufacture for home use in war-time. The list includes many substances which are used in chemical, biological and other laboratories, as well as those used by medical men and veterinarians.

## SUMMER SCHOOL IN X-RAY CRYSTALLOGRAPHY AT CAMBRIDGE

THE second Summer School of X-Ray Crystallography, held at Cambridge during September 4–15, was opened by Sir Lawrence Bragg, and the nineteen lectures, followed by sessions of practical work, were shared by Miss A. M. B. Parker and Drs. N. F. M. Henry, H. Lipson, D. P. Riley and W. A. Wooster. The organization and syllabus of the course were similar to those of last year (see *Nature*, Oct. 2, 1943, p. 381).

The application of X-rays to crystallographic problems of industrial importance has made dynamic advances, but remains a young science still largely cradled in the universities and similar academic laboratories. Many of the senior technical men attached to industrial organizations have had no opportunity of acquiring more than a superficial knowledge of the subject and its possibilities; while graduates just entering industry, though they may have received some training in X-ray methods, can scarcely be expected fully to appreciate their application to practical technology. A gap clearly exists which it was the purpose of the School in some measure to bridge; to quote the syllabus of the course, "the chief aim is to give scientists and technicians a training in the fundamentals of the subject, to bring them into touch with the wide range of methods used, to teach them the newest techniques, and to indicate the many types of industrial problems in which this work can be used with advantage". There is no doubt that these aims were admirably fulfilled.

Twenty-nine people assembled for the lectures, and as nearly half the number were concerned more or less directly with metals it is fitting that the course had a distinct bias, especially in its later and more practical part, towards the metallurgical field. During the first week attention was confined to the more fundamental aspects of the subject, dealing with the representation in projection of the symmetry and internal structure of crystals, the laws governing the 'reflexion' of X-rays from lattice planes and the several methods of taking and interpreting X-ray photographs of single crystals. In the second week, the knowledge so acquired was applied to the study of polycrystalline aggregates by means of 'back-reflexion' and 'powder' photographs, and the essentially practical nature of the course emerged. Familiarity was gained with such matters as the accurate determination of lattice spacings, the identification of crystalline substances and of the phases present in alloys; the assessment of preferred orientation, internal stress and grain-size in metals and the study of imperfect forms of crystals such as those occurring in rubber, textile fibres and plastics.

An important aspect of the more advanced work was the pains taken to point out the limitations of the methods at present available, and to indicate the probable lines of future progress. E. Voce.

## SPORE-FORMING BACTERIA PATHOGENIC TO PLANTS

IT is a curious fact that whereas the bacterial diseases of animals are due to many types including spore-formers, the large number of bacterial diseases of plants which have been carefully investigated are caused by bacteria which do not form spores. That some spore-forming bacteria of the *Bacillus subtilis* group can be pathogenic to plants has often been stated but never generally accepted by plant pathologists, either for lack of adequate proof or because of failure to obtain positive results on re-investigation.

There are, however, at least two accounts of experimental work which conform to the standards of rigid proof required in such work. Brierley (*Phytopath.*, 18, 819; 1928) presented good evidence to show that a bacterial rot of potato tubers was due to a spore-forming organism identified as a strain of *B. mesentericus*, and recently Madhok (*Indian J. Agric. Sci.*, 13, 129; 1943) has investigated a rot of tomato fruits due to a member of the same group and for which the name *B. fructodestruens* is proposed. A sticky bacterial rot of potato tubers is under investigation at Cambridge due to *B. polymyxa* which, according to Dowson (*Nature*, 152, 331; 1943), is pathogenic to a large number of plants including green tomato fruits when inoculated under laboratory conditions. Allen (*Nature*, 153, 224; 1944) has shown that certain strains of *B. subtilis* secrete pectinases which rapidly disintegrate pieces of raw potato when immersed in their solutions and which are concerned in the separation of flax fibres in retting.

From these investigations it would appear that some spore-formers of the *B. subtilis* group and *B. polymyxa* possess the necessary enzyme apparatus to attack and destroy the middle lamella of parenchymatous tissues under certain conditions, chief of which is the presence of water (not vapour), an adequate amount of which is necessary to start the enzyme system working.

The *B. subtilis* group has been recently investigated by Gibson (*J. Dairy Res.*, 13, 248; 1944), who has shown that this group of spore-forming bacteria can be considered as consisting of three main species each of which comprises a large number of closely related forms hitherto given distinct specific names. It seems possible, therefore, that failure to repeat some of the earlier work on the disintegration of plant tissues by some of these bacteria may be due to errors in identification. The possibility that other spore-formers may possess pathogenic powers as regards plants calls for further investigation and is much to be desired in view of the serious losses caused by bacterial rots.

# FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

### Saturday, October 28

TELEVISION SOCIETY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 3.30 p.m.—Mr. P. D. Saw: "New Types of Test Gear for Television Production".

### Sunday, October 29

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (joint meeting with the ASSOCIATION OF AUSTRIAN DOCTORS) (at the Austrian Centre, 69 Eton Avenue, Hampstead, London, N.W.3), at 11.30 a.m.—Dr. F. Bergel: "Life Saving and Life Preserving Plant Products".

### Tuesday, October 31

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Mr. B. E. B. Fagg: "Some Archæological Notes from Northern Nigeria".

CHADWICK LECTURE (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 2.30 p.m.—Mr. Somerville Hastings: "The Management of Hospitals in Peace and War".*

INSTITUTE OF PHYSICS (ELECTRONICS GROUP) (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. S. Rodda: "Beam Tetrodes".

PHYSICAL SOCIETY (joint meeting with the BRITISH INSTITUTION OF RADIO ENGINEERS) (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "Physics and Radio".

### Wednesday, November 1

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. E. F. Armstrong, F.R.S.: "Chemistry in the Service of Man".

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 3 p.m.—Dr. D. W. Kent-Jones: "Some Experiences of Microbiological Assays of Riboflavin, Nicotinic Acid and other Nutrient Factors"; Mr. W. N. Aldridge: "A New Method for the Estimation of Micro-quantities of Cyanide and Thiocyanate".

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. E. B. Moullin: "Theory and Performance of Corner Reflectors for Aerials"; Mr. H. Page: "The Measured Performance of Horizontal-Dipole Transmitting Arrays".

### Thursday, November 2

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 2.30 p.m.—Sir James Jeans, O.M., F.R.S.: "Old and New Descriptions of the Astronomical Universe", (i) "Planets".

INSTITUTE OF FUEL (YORKSHIRE SECTION) (at the Royal Victoria Station Hotel, Sheffield), at 3 p.m.—Mr. H. C. Armstrong: "Improvements in the Use of Fuels in Everyday Practice".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. J. Bruce: "Electrostatic Precipitation of Dust from Boiler-Plant Flue Gases".

### Friday, November 3

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 5 p.m.—Dr. E. B. Bailey, F.R.S.: "Mountains that have Travelled over Volcanoes".

INSTITUTE OF PHYSICS (at the Institution of Electrical Engineers Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. E. F. Relf, F.R.S.: "Air and Fluid Motion".

INSTITUTION OF MECHANICAL ENGINEERS (in conjunction with the APPLIED MECHANICS GROUP) (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Prof. A. J. Sutton Pippard: "Stresses by Analysis and Experiment".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6 p.m.—Sir Stanley Goodall, K.C.B.: "Some Technical Developments in Naval Construction" (Andrew Laing Lecture).

### Saturday, November 4

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 10.30 a.m.—Discussion on Civil Aviation. General Critchley: "The Selection and Training of Personnel for Civil Aviation"; Major Thornton: "The Economics of Air Transport"; Mr. Roy Chadwick: "Civil Aircraft Design"; Mr. E. W. Hives: "Civil Aero-Engine Design"; Mr. W. P. Hildred: "Route Facilities (Radio, Aerodromes, Meteorology, etc.)".

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. L. Hawkes: "On Jet Coal in the Chalk of Kent".

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

AGRICULTURAL TRAINING OFFICER to organize the scheme for the training in agricultural and horticultural occupations of men and women released from War service—The Executive Officer, Bucks. War Agricultural Executive Committee, County Offices, Aylesbury, Bucks. (October 31).

VISITING PROFESSOR OF GEOGRAPHY, VISITING PROFESSOR OF HISTORY, and VISITING PROFESSOR OF EDUCATION, in the Farouk 1st University, Alexandria—The First Secretary, Royal Egyptian Embassy, 75 South Audley Street, London, W.1 (October 31).

WATER SUPPLIES OFFICER, and an ASSISTANT LAND DRAINAGE OFFICER—The Chief Executive Officer, West Riding War Agricultural Executive Committee, Stray Hotel, Harrogate (November 1).

ELECTRICAL PLANT ENGINEER with first-class experience of both L.T. and H.T. equipment for an important Lancashire chemical engineering textile firm—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.932.XA) (November 2).

ENGINEERS OR PHYSICISTS (2) for Research and Development Department of Aeronautical Instrument Manufacturers (Hampshire area)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. A.647.XA) (November 2).

ASSISTANT (temporary) TO THE ADVISORY OFFICER IN MILK UTILIZATION—The Secretary, West of Scotland Agricultural College, Blythswood Square, Glasgow (November 3).

PSYCHOTHERAPISTS for work on a sessional basis with children and adults in the Psychiatric Out-Patient Clinic under the supervision of the Honorary Psychiatrist—The Secretary, Manchester Northern Hospital, 38 Barton Arcade, Manchester 3 (November 4).

HEAD OF THE ENGINEERING DEPARTMENT of Cardiff Technical College—The Director of Education, City Hall, Cardiff (November 6).

LECTURESHIP IN CIVIL ENGINEERING in the University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (November 6).

CIVIL ENGINEER (Reference No. N.1163.A) and an ASSISTANT ENGINEER SURVEYOR (Reference No. E.1164.A) by the Department of Comptroller of Development and Welfare, West Indies—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting the appropriate Reference No.) (November 7).

CHEMICAL ENGINEER with good Science Degree and experience in design and development (preferably also of operation) of Heat Exchange Equipment and Chemical Plant generally, as Assistant in Technical Department of Gas and Chemical Plant Contractors—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2316.XA) (November 7).

COMBUSTION EXPERT who is accustomed to the application of scientific principles to large steam generators, by the London Power Company, Ltd. (a good Degree in Chemistry with Physics subsidiary, or vice versa, and research experience are desirable)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2240.XA) (November 7).

LECTURER (temporary, full-time) IN ELECTRICAL ENGINEERING SUBJECTS to Honours Degree and Higher National Certificate standards in the Cardiff Technical College—The Director of Education, City Hall, Cardiff (November 9).

GRADUATE TEACHER OF MATHEMATICS and/or SCIENCE in the Grimsby Technical College—The Director of Education, Education Offices, Grimsby (November 10).

GRADUATE ASSISTANT FOR GEOGRAPHY AND SCIENCE, in the School of Building, an ASSISTANT with ENGINEERING Degree or equivalent qualification in Structural Engineering, in the School of Building and Department of Engineering, and an INSTRUCTOR with experience in ELECTRICAL ENGINEERING, in the Department of Engineering, of the East Ham Technical College—The Secretary for Education, Education Office, Town Hall Annexe, Barking Road, East Ham, London, E.6 (November 11).

BACTERIOLOGIST on the staff of the Water Pollution Research Laboratory, Watford—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2248.A) (November 11).

CIVIL ENGINEER, and an ASSISTANT to the Civil Engineer, by the Government of Seychelles—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.1167.A) (November 11).

LECTURER IN THE ELECTRICAL ENGINEERING DEPARTMENT, and a LECTURER IN MATHEMATICS—The Registrar, Technical College, Sunderland (November 13).

EDUCATIONAL PSYCHOLOGIST, and a PSYCHIATRIC SOCIAL WORKER—The Secretary for Education, County Education Offices, Northampton (November 13).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, The University, Manchester 13 (November 21).

PROFESSIONAL OFFICER (Grade I) in Ceramic and Refractory Research for the Government Metallurgical Laboratory, University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, W.C.1 (November 30).

RESEARCH WORKER (temporary) to assist in work on Fish which is being carried out in association with the Ministry of Agriculture and Fisheries—The Director, Freshwater Biological Association, Wray Castle, Ambleside, Westmorland (December 10).

DAVID JARDINE CHAIR OF ELECTRICAL ENGINEERING (with special reference to Electronics and the relations between Electrical Engineering and Physics)—The Registrar, The University, Liverpool (December 29).

LECTURER IN GEOLOGY (Grade IIb)—The Secretary, The University, Birmingham, 3 (December 31).

LECTURER IN MECHANICAL ENGINEERING—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18.

TEACHER OF MATHEMATICS in the Maidstone Technical Institute—The District Secretary, Kent Education Committee, 13 Tonbridge Road, Maidstone, Kent.

ADVISORY DAIRY BACTERIOLOGIST for the West Midland Province—The Principal, Harper Adams Agricultural College, Newport, Shropshire.

KEEPER OF THE DEPARTMENT OF CERAMICS, TEXTILES, COSTUME and FURNITURE—The Director, City Museum and Art Gallery, Birmingham, 3.

ERECTOR SERVICE ENGINEER for the Sisal Control, Tanganyika Territory—The Secretary, Overseas Manpower Committee, Ministry of Labour and National Service, Alexandra House, Kingsway, London W.C.2 (quoting Reference No. 1441).

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## CONTENTS



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# LAND USE AND SOCIAL ADJUSTMENT

THE scheme outlined in the White Paper on the Control of Land Use* issued by the Government in June last, together with a Bill facilitating the public acquisition, at 1939 prices, of damaged and decayed urban areas in Great Britain for planned redevelopment as single units, although following closely the recommendations of the Uthwatt Report on this aspect of the problem, had a poor reception. The merits of the Government scheme as a means of solving the particular problem of compensation and betterment have in fact been obscured by dissatisfaction with its attitude towards the wider question of land-ownership, and with its unwillingness to adopt a positive planning policy. The importance of the latter has been emphasized by events during the recess.

It is now accepted on all sides that planning control is necessary to secure the best use of the land in the public interest, that planning control is frustrated by the practical impossibility of balancing compensation and betterment under the present system of land ownership, and that therefore this system must be modified to the extent required to make effective planning control possible. Meanwhile, the question of the best use of land, as between the claims of housing and farming, of commerce and amenities, is a matter of the utmost urgency and importance. It is no longer a question of merely saving land : it is a matter of saving and using.

The news that Britain is to be increasingly searched for oil-fields, while welcome from the point of view of self-sufficiency in war, at least carries the risk of loss to our countryside which may outweigh any commercial advantage in the long run, and is clearly a matter to be determined by national considerations and planning. So too the controversies aroused by the proposed power-stations at Durham and Lincoln, the Highland water power scheme or even the City of London Plan and the Plymouth Plan, emphasize the imperative necessity of some real national planning of resources. Each plan proposes alterations, for the benefit of specific interests, to scenes which are generally regarded as part of the national heritage, and except in the Plymouth plan, where the proposals cannot be implemented effectively except as part of a national plan backed by national resources, there is little evidence that the wider national or regional interests have been considered.

The strong criticism advanced by Mr. Hugh Quigley of the North of Scotland Hydroelectric Board Scheme approved by the Secretary for Scotland in March has never been effectively answered and indicates the unsatisfactoriness of the general situation. Constructional Scheme No. 1, covering Lochs Sloy, Morar and Lochalsh, Mr. Quigley points out, forms no part of any plan for the Highlands. Provided with inadequate maps, it contains no reference to town and country planning schemes or to economic development of any kind. The Board, instead of

* The Control of Land Use. (Cmd. 6537.) Pp. 16. (London: H.M. Stationery Office, 1944.) 3*d*. net.

preparing its own schemes, appears to have accepted those prepared by consulting engineers or requested them to prepare such schemes, and, according to Mr. Quigley, there is no evidence that the final scheme was submitted to or approved by the Amenities or Fisheries Committee. Even now the main development scheme has not been published.

Mr. Quigley's criticism cannot but arouse profound misgivings as to the whole hydro-electric development scheme for Scotland, in any event while the Minister of Town and Country Planning possesses such inadequate powers. At present, instead of drawing up a broad master plan of how such areas of national concern as Durham, Lincoln, Plymouth and Oxford, the Highlands and London, the caravan camps and the housing estates, shall be handled for the good of all, he must depute the task piecemeal to representatives of those very interests at whose hands the community and the landscape have suffered much. Local authorities have not necessarily incentive or resources to weigh with strict impartiality the national against the local, the individual against the general issues.

In a small island such as Great Britain, the liberty of the community can only be achieved by some sacrifices of individualism, and the guardian of the community's landscape can only be a national ministry. Unless, however, Mr. W. S. Morrison's office is given much greater preventive and constructive authority than at present, local and individual interests may well continue to trespass in the names of freedom and progress upon that scenic heritage which is irreplaceable.

The situation is in fact even more serious than this might suggest. Despite the acknowledged need for regional planning and for redistribution and reform in local government, the Government has indicated that it has no present intention of embarking on local government reform. It may well be doubted, in fact, if the necessary inquiry could be brought to fruition in time for effect to be given to any recommended scheme of reorganization before action on immediate post-war reconstruction and development is necessary. Reorganization cannot be postponed indefinitely, as each successive measure of reconstruction in fields such as education and health and town and country planning shows, and Prof. and Mrs. J. R. Hicks' recent study, for the National Institute of Economic and Social Research, of the problem of valuation for rating indicates that the whole system may well break down for financial reasons.

None the less, the conception of such schemes as the plan advanced for Plymouth, with its striking evidence of the vision of at least some local authorities, should not lead us to forget the danger that such breadth of vision and national outlook may not be characteristic or universal. Furthermore, as the debates on the control of land use in the House of Lords and on the Town and Country Planning Bill in the House of Commons have shown, progressive local authorities may not be in a position to implement their own plans. It was made clear when the Plymouth Plan was first published that support on a national scale would be essential if some of its proposals were to take effect: it must be part and parcel of a national plan.

The position of Plymouth was described in the House of Lords by Viscount Astor, who pointed out that to carry out the Abercrombie–Watson plan meant that the future population of Plymouth would be limited to a maximum of 180,000 as compared with 220,000 before the War. It is impossible to expect a population thus reduced in size and with its rateable value further reduced as a result of war damage to bear the burden of such replanning; to preserve the values and population which are commonly described as 'overspill', Viscount Astor urged not merely financial help but also an amalgamation, so that people who earn their money in Plymouth but live outside continue to be citizens and that the values which move from Plymouth to the adjoining districts are preserved within the area as a whole. Lord Woolton, it is true, during the House of Lords debate, promised that some form of financial assistance would be made available for the acquisition by local authorities of approved open spaces where such acquisition would impose an undue financial burden on the authority, but this provision does not meet the situation created by 'overspill'.

Other cities and towns, such as Bristol, Cardiff, Dover, Great Yarmouth, Hull, Portsmouth and Sunderland, are in a similar plight, and their local authorities have appealed for legislative help by an amendment to the Town and Count y Planning Bill to enable them to replan these cities on modern principles. While the devastation of war has facilitated an immediate recasting of layouts, such cities have insufficient land to house their citizens if they plan according to modern ideas by including green belts and open spaces. To avoid serious loss and incurring heavy liabilities, they call for security now by an extension of their borough boundaries. They cannot afford the delay and uncertainty of another Bill for the general revision of local authority boundaries, which the Minister of Health hopes to introduce in a later session.

The amendment which was requested is of more than local interest. By it, if the Minister, on representations by a borough in which there has been specially heavy and widespread damage due to enemy action, was satisfied that the carrying out of an adequate planning scheme would be delayed or frustrated because the scheme would lead to a serious loss of population, he would be empowered to initiate an inquiry. The tribunal set up, after taking evidence from all interests likely to be affected, would have power to recommend an extension of the borough's area. With such an amendment the 'blitzed' cities would be able to go ahead and to act as planning laboratories for the whole country, providing an invaluable practical test of bold, up-to-date planning. To this amendment Lord Justice Scott has lent powerful support, pointing out that it averts the imminent danger of the country losing a splendid opportunity of putting into practice the Scott Report and the Barlow Report. The debate on this amendment showed clearly the difficulties involved in dealing with this particular

situation separately from the general question of local government boundaries and areas. Support for the amendment was not unanimous, although the urgency of the situation was generally admitted, and Mr. W. S. Morrison gave a convincing reply in indicating his inability to accept the amendment. The danger of prejudicing a settlement on broad and permanent lines of a wider question which is already under consideration by the Government is clearly great, and much of the force of the argument in favour of the amendment was withdrawn when it was announced by Mr. Morrison and by the Minister of Health that a White Paper on Local Government would be laid before Parliament before Christmas and that legislation would follow in the next session. The amendment was withdrawn; but the situation is a severe defeat for the Government's attempt at piecemeal measures and forces it back to first principles, by which alone the dilemma of the 'blitzed' cities can be resolved.

It cannot, of course, be maintained that the Bill and the White Paper are not very incomplete. The Bill deals with the particular problem of the acquisition of land in large blocks by local authorities for the purpose of planning the redevelopment of areas as units. The White Paper deals with the more general problem of seeing that the use made of land by its owners is not contrary to the interests of the community, that values created by the community are recovered for the community, and, conversely, that property acquired in good faith is not arbitrarily or discriminately confiscated by the actions of the State. In the atmosphere of prejudice created against the Bill, something less than justice was done both to it and to the White Paper, and their reception cannot but arouse misgivings as to whether the problems of reconstruction will be tackled in a scientific manner and with knowledge and realism. At least, with the qualification already noted, the Bill gives the local authorities the essential minimum of what they require and, freeing them from their paralysing uncertainty, enables them to proceed with their plans, even if in circumstances not quite so favourable as they had hoped.

Again, the White Paper, while lacking the simplicity of outright nationalization, differs from the Uthwatt proposals in several respects, but on the whole, the new proposals seem to be more clear cut and for that reason to be preferred. With the Bill, the White Paper represents the first major advance into a region that has been much discussed but little explored, and the Government's plan has the major merit of treating both urban and rural land on the same footing. Moreover, the decision to transfer responsibility for paying compensation and collecting betterment to a national land commission relieves local authorities of the need to permit as much development as they prohibit within their own areas, regardless of the dictates of good planning. The proposals do not foreshadow the appearance of that national plan which has also been promised, and the need of which has been emphasized by the inquiries at Lincoln and Durham as well as in the debates. In fact, the power given by the Bill to a few local authorities to start the positive planning of the use of land in their cities increases the urgency of the need for a national framework within which such local efforts can find their place.

Moreover, the matter becomes more urgent as the problem of employment is faced. The latest report of the National Trust* indicates the tendency. The most recent additions bring the area owned by the Trust up to 100,000 acres, with another 39,000 areas controlled, but the increase is less than in recent years and the rate of increase is likely to diminish in future. This is a probable consequence of comprehensive control by the State of the use of land, and the Trust will clearly require to give careful consideration in such circumstances before accepting large tracts of land, especially when situated in the neighbourhood of densely populated areas with potential demands for residential or industrial development. Again, if national parks are to be set up under the control of a statutory body of commissioners, the work of the Trust in those particular regions may diminish in importance.

What is clear from this report is that if the importance of the National Trust in saving land, such as beauty spots, for the nation is decreasing, its importance as a land user is increasing. With the large area now under its administration, the National Trust is concerned with estate management, farming and forestry on the grand scale. It has to see that preservation does not mean sterilizing our scenic heritage. Its policy, as in national parks, must be to combine the maintenance of the countryside at its best as a historic legacy, a place of recreation and a source of food, timber and minerals.

The combination of the highest efficiency in farming and forestry with the greatest measure of public access and with the fostering of bird, insect and plant life is no simple problem, and for the Trust is enhanced by the low fertility of much of its property. The report emphasizes the exceptionally experienced administration and control that are required. Yet another problem is that of the use to which many of the larger houses acquired by the Trust could be put, and difficulties in the way of adapting them either to institutional use or for recreation while preserving their character unimpaired.

This tendency, noted in the report of the National Trust, is even more marked when we come to consider the questions of industrial development and the re-location of industry. The replanning and rebuilding of our war-damaged towns and cities, like the planning of the countryside of Britain and the housing problem generally, as was well shown in the recent *Planning* broadsheet, "Location of Employment", is linked up with the question of employment. The houses must be built where the men and women who are to live in them will find their employment. Hence the importance of those proposals for the development of the north east of England advanced by the Northern Industrial Group, and of Lieut.-Colonel W. C. Devereux's proposals for the industrial reconstruction

* National Trust for Places of Historic Interest or Natural Beauty. Report of the Council for the Years 1943–1944. Pp. 62+8 plates. (London: National Trust.)

of South Wales, and more recently for the industrial development of West Cumberland.

What is significant here, however, is the consciousness in these plans in the *Planning* broadsheet and in the debates in the House of Commons on the Town and Country Planning Bill, that not merely is a better balance of industry and labour required, as is declared in the Government's White Paper on Employment Policy, but also the development of real communities.

This is the essential point brought out in a report of the Social and Industrial Commission of the Church Assembly, "The Church and the Planning of Britain"*. Emphasizing that physical planning alone is not sufficient and that industrial mobility has an inherent threat to domestic life and the stability of urban life, with consequent social disintegration for which no degree of physical planning, however wisely directed, can compensate, it directs attention to a problem which has frequently been overlooked. As the report notes, the liability of employees of banks and certain types of firms, especially those who have reached managerial positions, to be moved from one place to another, while frequently unavoidable, is adverse to the development of civic and religious responsibility and stability. Moreover, to the extent to which the incidence of such mobility is heaviest on those who have proved their capacity for responsibility and leadership, it tends to deprive the local community of those who would be its natural leaders.

If it is true that greater mobility must be part of the price we have to pay for social security and full employment, as Mrs. Gertrude Williams has suggested, it is important that every effort should be made to minimize any ill consequences. The Church Assembly report points to five ways in which the present housing situation and social and economic background fail to satisfy the basic psychological needs of men and women: the limitations imposed on family needs by its restriction of domestic space; the lack of connexion with man's vocational life; the encroachment upon leisure and the imposition of 'rush-hour' conditions involved in its remoteness from the scene of work; its false isolation and lack of facilities for a natural communal life; and the cramped character of the environment its creates, which denies opportunities for withdrawal.

From this point of view, the report concurs with Mr. Lewis Mumford's view that good planning in the post-war period will rest on the solid foundation of the family, and the region; it will emphasize the biological and social needs of the people, and treat industrial and financial needs as subordinate. Quoting the Barlow Commission's conclusion that the disadvantages in many, if not most, of the great industrial concentrations alike on the social, the strategic and the economic sides constitute serious handicaps, and even in some respects dangers, to the nation's life and development, the report urges that more important than the size or area of a town or conurbation is the expression of size as a function of the social relations to be served. Proper planning and adequate spacing must be demanded in old towns and in new units, and apart from amenities the report urges that those migrating from congested towns must be welcomed into real communities with social life, established or in contemplation, and with proper provision of churches and chapels, schools and playgrounds, halls and social meeting centres and theatres.

The insistence in this report that dispersal or decentralization must be based on the principle of the living community, with adequate facilities not only for housing but also for living, working, and recreation—a community in which local life is developed and generous provision made for the moral and spiritual needs of the population—is a welcome reminder that the problem of the right use of land is linked up with the central problem of democracy, namely, that of securing the framework within which its essential spirit can have the fullest possible play. It is the problem of morale which confronts us here, that of securing a better balance between industry and agriculture, between public control and private enterprise, and the fuller integration of industry with the needs of the community. Already the debates on the Town and Country Planning Bill have demonstrated the need for effective machinery for adjustment, and the complexities of modern life make the problem increasingly difficult and important. Whatever solution may be found to the immediate problems of the control of the use of land before reconstruction can proceed, there will be no final solution until we have solved this wider and deeper problem of developing the organization or mechanism by which a living community can adjust itself continuously to its changing conditions, retaining both firm control over its environment and at the same time the freedom which the human spirit requires for its intellectual, moral and spiritual development. The proper way of planning things, as the Church Assembly report notes and experience has shown, is to secure the kind of structure which ensures that individuals and small groups in co-operation shall learn to control the material and the administrative adjustments of their own immediate surroundings, and so gain larger insights into, and control over, the wider world of affairs. If we are to save freedom we must proceed, as the late Archbishop of Canterbury has reminded us, from democracy of the individual to democracy of the person, and recollect that personality achieves itself in the lesser groupings within the State—in the family, the school, the guild, the trade union, the village, the city, the county. No physical planning will serve the needs of the post-war world which does not provide for the fostering of these and like loyalties, which have sprung up in civil defence and other activities under the stress and demands of war.

Such objects of loyalty can and do contribute to the wealth of tradition and inheritance of the State and thereby to its stability. Already the storm over the compensation clauses in the debate on the Town and Country Planning Bill has shown that, unless such loyalties are subordinated to, or rather integrated into, a higher loyalty, there can be no hope of solutions to problems so essential in the national interest. As

* The Church and the Planning of Britain. Report of the Social and Industrial Commission of the Church Assembly, 1944. (C.A. 753.) Pp. 32. (London: Church Assembly.) 2s.

the Prime Minister rightly said, for all its shortcomings the Bill is needed, for without it planning and reconstruction cannot proceed. The appeal to national unity and to a spirit of reasonable compromise will, it is to be hoped, be heeded. That such an appeal should have been necessary at this late hour is an unmistakable warning of the urgency of much greater attention to this question of public morale, and the fuller integration of group interests and loyalties with the larger and wider interests of the community. Important as may be the service which science can render in different ways to the planning of the use of the land and other material resources, it might make an even more significant contribution to the vast field of post-war reconstruction by an adequate attack on the problems encountered in the field of public relations—what Lord Stamp described as the science of social adjustment.

## THE STORY OF ANATOMICAL EXPLORATION

**A History of Comparative Anatomy**

From Aristotle to the Eighteenth Century. By Prof. F. J. Cole. Pp. viii+524. (London: Macmillan and Co., Ltd., 1944.) 30*s*. net.

INTEREST in the structure of animals must have occupied the mind of man from remote antiquity, ever since they were the object of the chase and required to be prepared for food. Even palæolithic man indicated the surface anatomy of vital organs in his mural paintings of animals, and occasionally exercised his artistic propensities in making exquisite carvings of the flayed heads of horses, depicting the muscles with remarkable precision. From time immemorial, also, primitive communities have shown the liveliest interest in the individual variations of the visceral anatomy of domestic animals, using these variations as omens on which to base decisions of policy. But the study of comparative anatomy, which is essentially the search for common denominators in organic structure, is a scientific method, and could only be the product of philosophic inquiry into the meaning of life and living things.

It is with the history of this approach to biological problems that Prof. Cole deals in his brilliant treatise on the development of anatomical practice and thought from the time of Aristotle up to the eighteenth century. It is true to say that many biologists have been impatiently waiting for this book. Prof. Cole's erudition and scholarship as a historian of biological science are well known, and there is no doubt that in his particular field of study he stands pre-eminent to-day. In his preface the author informs the reader that he had originally intended to write an exhaustive history of zoological discovery, based on protracted and laborious searches carried on during many years. Considerations of brevity imposed by present-day circumstances, however, compelled him to put aside for the present this project, and he has contented himself with a more limited objective. But if the objective was necessarily limited, the result is highly impressive.

To the comparative anatomist whose acquaintance with the historical development of his subject is not so intimate as he might wish, a glance through Cole's book will cause surprise at the wide field covered by the old comparative anatomists (particularly of the sixteenth and seventeenth centuries), at their meticulously detailed descriptions, at the artistry and accuracy of their illustrations, and at their technical skill. A closer reading leads one to ponder on the motives and incentives which led to the development of this science, and suggests a continuous repercussion of two main driving interests. One of these is the ever-present urge in the human mind to reduce order out of chaos, to classify, and to search for a common plan underlying a profusion of variety. So arose the systematists who, beginning with Aristotle, gradually worked up to the impelling conception of the *Echelle des êtres*, which dominated the minds of zoologists in the immediately pre-Darwinian era. Belon, Rondelet, Aldrovandus, Coiter, Gesner and others represented this field in the sixteenth century. Belon's work is noted for his study of homologies in the human and avian skeletons, and he may perhaps be regarded as the initiator of the science of pure morphology. Coiter's magnificent publications on comparative osteology arouse admiration largely because of the superb illustrations executed by himself. His figure of the articulated skeleton of a capuchin monkey, for accuracy of delineation and effectiveness of technique, would be regarded as excellent in any anatomical monograph of to-day. Incidentally, it might be interesting to investigate the correlation between anatomical achievement and artistic ability, for both require an aptitude for visualization of an unusual kind. It seems not improbable that some of the anatomical books which appear in modern times really owe their origin to the pleasure which the authors obviously experience in illustrating them.

Despite the care and thoroughness with which medieval systematists conducted their studies, it is remarkable that they were often unable to break away from purely popular conceptions of classification. For example, the porpoise seems to have occupied the puzzled attention of several comparative anatomists—Belon in 1551, Ray in 1671 and Tyson in 1680. Yet, in spite of the evidence of their eyes, they continued to classify it with the fishes. But it is evident that this conservative view was accepted with some reluctance. Tyson remarks that when we view the porpoise externally there is nothing more like a fish, but when we look within there is nothing less like one. He even says he would *like* to think it is not a fish, but this is as far as he is prepared to go in the face of popular assumption. Although Tyson's anatomical studies covered a wide field of vertebrates and invertebrates (among other things he gives the first anatomical description of a marsupial), he is perhaps best known for his study of the chimpanzee, a noteworthy contribution to the study of systematics, for it brought man himself into much more direct relation with lower mammals. The chimpanzee, he concludes, is "no *Man*, nor yet the *Common Ape*; but a sort of *Animal* between both".

Comparative anatomical exploration during the latter half of the seventeenth and the first half of the eighteenth centuries was very prolific, but was pursued with little attempt at the formulation of general principles of morphology; so that, as Cole points out, Vicq D'Azyr in 1786 was concerned to direct attention to the masses of undigested and incongruous facts which had been assembled and to complain that they tended to produce a feeling of fatigue and weariness in the reader. Yet it was this

field of study which led to the development of the transcendental philosophy of anatomy in the early part of the nineteenth century, a philosophy which, although sterile in itself, was almost a necessary precursor of the evolutionary conceptions which rapidly followed. At the same time, it is a remarkable fact that, as E. S. Russell points out in his book "Form and Function", when the evolutionary conception was at last raised to the level of a scientific hypothesis, it was from pure morphologists such as Cuvier and von Baer that the most violent opposition arose.

We have noted that one of the incentives which initiated the study of comparative anatomy was the innate tendency of the human mind to systematize and classify. The other powerful incentive arose from the development of medical science. It is easy to understand that, in the period when the difficulties in the way of dissecting human corpses were immense, zootomy became a common practice as an indirect method of approach to the study of human anatomy. Indeed, as is well known, some of the early descriptions of human anatomists were vitiated by the fact that conditions peculiar to lower animals were sometimes reported as normal for man. Even Galen and Vesalius bear some responsibility for such errors. But, apart altogether from considerations of practical necessity, many human anatomists of the sixteenth and seventeenth centuries deliberately studied animal structure in the belief that their simpler organization might provide an opportunity for determining functions which are obscured by too great a complexity in man. This, of course, is one of the essential aims of comparative anatomy and was the view of Casserius in 1601 when he expressly claimed that the fabric of man could be explained by reference to lower animals, and of Samuel Collins, physician to Charles II, who wrote in 1685, "I humbly conceive the great use of comparative anatomy is to illustrate the structure, actions and uses of the human body".

The idea was grandly conceived, but the records of comparative anatomy up to the present time have disclosed the limitations of such a method. Even Malpighi was constrained to confess in the introduction to his "Anatome plantarum" (in 1675) that he had been disappointed in its results. But the study of comparative anatomy with reference to human structure and functions was fully vindicated by the realization that lower animals could be made the subject of experimental investigation, and for this purpose the establishment of homologies and analogies in the structure of different species became a most essential preliminary. The significance of comparative anatomy for the experimentalist was evidently realized by a number of early anatomists, starting with Galen. But it was Harvey who first developed this method of approach in the study of human functions, though, as Cole emphasizes, to him the lower animals were also worth studying for their own sake and for the light they throw on the fundamental truths of biological science. It is possible that even to-day the limitations of pure comparative anatomy as a method of elucidating function are not always fully recognized. It is a method of the utmost value as a preliminary survey for experimental investigation, and it can often offer important clues and hints to the physiologist, but it may be doubted whether comparative anatomy *by itself* has ever been able to supply the final proof of the function of any structure the significance of which is in any way obscure.

In the concluding part of his book Prof. Cole discusses the value of a knowledge of the history of scientific learning to the modern man of science and rightly urges that more attention should be given to it in the educational curriculum. Among other things, it helps to develop that sense of humility which is surely a desirable attribute for the research worker who aims at high achievement. But we would demur from Prof. Cole's suggestion that "future generations will view with amusement the involved jargon and mechanical elaboration which condemn the chromosome theory of heredity and remind us of the evanescent frenzy of the nineteenth-century transcendentalists". After all, the modern geneticist can claim that his conclusions are based, not on superficial analogies and philosophical abstractions, but on a solid abundance of carefully controlled experimental work.

Prof. Cole's book is without doubt one of the great works on the history of biological science. It is the product of mature thought and many years of bibliographical research, and the fact that the author himself is a professional biologist gives it additional value. In spite of war-time restrictions on the quality of paper available for a production such as this, it is extensively adorned with excellently reproduced illustrations. It is to be hoped that Prof. Cole's original intention to write a much more comprehensive work on zoological discovery will find its realization before long.

W. E. Le G. Clark.

# PROBING THE METABOLIC SECRETS OF THE TISSUES

## Creatine and Creatinine Metabolism

By Prof. Howard H. Beard. Pp. x+376. (London: Chapman and Hall, Ltd., 1943.) 24*s*. net.

SINCE Prof. A. Hunter published his monograph on "Creatine and Creatinine" in 1926, much experimental evidence has accumulated. At intervals since then there have been reviews but probably none so full as the present monograph by Prof. Beard. His contribution represents a fresh approach to the problems of creatine and creatinine metabolism.

Creatine is the chief nitrogenous constituent of muscle tissue, and the author submits reactions to illustrate the synthesis of creatine and creatinine *in vivo* and *in vitro*. Despite the fact that glycocyamine has long been recognized to be methylated to creatine in the animal body, its role as a creatine precursor has not apparently been accepted until recently.

It is held that the mechanism for creatine synthesis from urea and glycine resides in the muscles, while that of arginine and glycine resides in the kidney, and that methylation takes place in the liver. The muscles, liver and kidneys are apparently the tissues chiefly concerned with the formation of creatine and creatinine from most of the amino-acids of the diet. It is also certain that creatine can arise from creatinine *in situ* in the body and also in *in vitro* studies.

The author considers that from data secured in 1925 he was able to obtain probably the first definite evidence against the distinction between exogenous and endogenous metabolism. The recent brilliant work of Schoenheimer *et al.* in this field has shown that the newly formed creatine (and creatinine) molecules acquire their parts from the food as well

as from tissue components, for example, the amino-acids, arginine and glycine. This is taken as further evidence against the concept of two independent (exogenous and endogenous) types of catabolism. H. H. Mitchell, on the other hand, appears to hold that tissue creatine is very constantly undergoing dehydration to creatinine (which is eliminated by the body as a useless metabolite); that it is being constantly formed, and that the rate of its synthesis cannot be readily accelerated by an over-abundance of its precursors in the tissues, nor by the administration of amino-acids. The author, however, considers that creatine and creatinine represent uniform rather than constant metabolites, and their formation and excretion are governed by the rate of protein metabolism, and that Mitchell has not really offered evidence to refute Schoenheimer's views.

There is at present a considerable difference of opinion as to whether the feeding of gelatin (with its high content of glycine), or glycine itself, will increase the energy output in man. In Prof. Beard's experience only 75 per cent of a given number of individuals will show increases in energy output, with the other 25 per cent exhibiting nothing after glycine or glycine-urea ingestion. This he considers to be a normal physiological variation between individuals and should be recognized as such. It is held by the author that glycine will not form creatine unless a normal or high protein diet is fed at the same time, as otherwise the glycine or the amino-acids hydrolysed from gelatin will go first to meet this demand. Although the author believes in the beneficial action of glycine the case for glycine is, on the balance of evidence, 'not proven'.

Much of what is described here is still highly controversial and is certain to stimulate much discussion. If a fault may be found it relates to the author's enthusiasm for the role of glycine in the treatment of varied clinical conditions. It is here that he will probably encounter most criticism; but although his account appears to have this bias it will most certainly have been of value if it stimulates further work.

D. P. CUTHBERTSON.

## PLASTICS MADE EASY

**Plastic Horizons**

By B. H. Weil and Victor J. Anhorn. (Science for War and Peace Series.) Pp. ix+169. (Lancaster, Pa.: Jaques Cattell Press, 1944.) 2.50 dollars.

THIS little book is worth careful examination, for it may represent the kind of thing with which the public is fed or doped in the days to come. In the 'blurb' on the dust cover it claims to take up where the newspaper articles and institutional advertising leave off. It is a back-to-earth job in which curiosity and interest in plastics will be supplanted by actual working knowledge. To use the author's favourite expression it may, and then again it may not.

The book starts well from the conception that we can scarcely help noticing the world around us: countless changes begin to intrigue our fancy and stimulate our imagination. This is largely true of America, thanks to a Press which is more and more prepared to direct attention to the progress of science and to display attractive advertisements which make names and processes known to a public which is ready to accept anything new. It is far from true of Great Britain, where the masses are conservative. Proof of this is afforded by the reception given to the 'Portal House', which represents quite the finest step forward in domestic engineering of this century. The British Press has not yet learned to talk about science, its occasional efforts are too often characterized by exaggeration and inaccuracy, our advertising is poor. Scientific workers as a class do not want publicity, least of all that which is associated with a particular name, often the wrong one.

Assuming we have an interest, such as our forefathers did, in the things we use, what can we learn about plastics? The word is now an accepted one though it involves a contradiction, and we use it as descriptive of a large number of substances which the chemist makes of the most diverse properties—billiard balls, 'Nylon' stockings, telephones, glues and lacquers. I think we should encourage the definition that the chemist makes them from a few simple substances which he can procure quite inexpensively in quantities of thousands of tons, for it leads to the next question, How does he make so many different things from these few starting materials? The authors plunge us into structural chemistry and are not afraid to cover several pages with structural formulæ, which inspires a wholesome respect for it and the molecular engineers who follow its precepts. The phrase is a good one, for those who engage in synthetic chemistry are 'molecular engineers' building up from small molecules, with only two atoms of carbon, and thus comparable with bricks, a mighty structure composed of thousands of molecules. These molecular chains vary; when they are long and contain little interlinkage they can be worked and re-worked and are termed thermoplastic. But if there is much cross-linkage between the chains the first heating sets up a rigid molecular structure and the product is thermo-setting.

The authors get us thus far in fifteen pages, and it will be admitted that they have done a good job in getting the idea of molecular structure across. The book goes on in this fashion, telling us about moulding, about particular resins, how they are made and from what materials—our interest is continually stimulated. But people are most interested in uses, for war to-day and for peace purposes to-morrow, so we are told something about these. This section is rather superficial and too much a catalogue without indication of the why and wherefore of its use: the chapter is below the standard of the early part of the book. The authors have more scope when they come to synthetic fibres and synthetic rubber, two things about which the public really want to know; the chapter contains a lot of information and an indication of the competition to be faced.

The final subject, plastics and the future, is one which gives scope for the enthusiast; but the authors, while stimulating, are commendably restrained. Plastics will supplement rather than supplant the traditional structural materials, applications will multiply, prices will grow less, the versatility of the materials will find new uses for them, but we are not on the eve of a plastics age nor will their use solve all the problems of man.

I have written enough to show that I find this a readable book, written on a high level though essentially popular, and one which would help in the understanding of what the chemist is doing and can do if it could only reach a large section of the public. I think it fulfils the authors' aspirations.

E. F. ARMSTRONG.

# ROBERT WIGHT (1796–1872), DR. FREKE AND THE "ORIGIN OF SPECIES"

By T. E. T. BOND
Tea Research Institute of Ceylon

AN interesting sidelight on the Darwinian controversies of the early 1860's is afforded by some fragments of contemporary correspondence which have recently come to my notice and which are worth placing on record as much for their subject as for their intrinsic merit of style. The documents accompanied some volumes of Robert Wight's Indian botanical works—the "Illustrations of Indian Botany" and autographed copies of the "Spicilegium Neilgherrense" and vol. 6 of the "Icones Plantarum . . ."—generously loaned to the library of this Institute by his great-grandson, Mr. H. C. Cosens, who is a Ceylon tea planter. They consist of four draft letters in Wight's handwriting addressed to Dr. Freke, of Dublin, on the subject of two pamphlets by the latter author which are also preserved with the letters. Freke is largely concerned with establishing the priority of his own views over others which he attributes to Darwin; Wight, in his letters, has some trenchant observations of his own to make as to the relative merits of the conclusions reached by these two authors. I have no means at present of finding out whether the final version of the letter was ever sent or, if sent, whether it is still in existence; nor have I the opportunity of following up many of the points of historical and biographical interest which are raised by this material. In this article I shall not attempt to do more than briefly introduce the two characters concerned and thereafter, so far as possible, allow the papers to speak for themselves.

Robert Wight left India in 1853, so that all his botanical works while in that country might be expected to have a 'pre-Darwinian' flavour. As anyone who is in the least acquainted with them will know, they are indelibly stamped with his own forceful and vigorous personality in addition. The blending of the age and the man is seen nowhere to better advantage than in his preface to the "Spicilegium Neilgherrense", written, presumably, in 1846. A follower, for practical purposes, of the de Candollean modifications of Jussieu's system, he here enlarges on the desirability of attaining to a still closer approximation of "the true Natural System of Botanical classification, now so ardently sought for by all philosophical Botanists". He is indeed well aware of the difficulties in the way, not the least of which is that, as he says, ". . . even the most learned and philosophical among them, seem not to know quite clearly what they are in search of and of course can scarcely be expected to inform others what they do not well understand themselves".

Having disposed of the argument that the natural system "is neither more nor less than a human contrivance", and demonstrated that there can only be one such, namely, that which repeats the design of the Creator, he proceeds to show that the "*Circular* method" affords the best clue to its discovery. The system that is favoured presupposes a ternary, or rather quinary, subdivision of the animal and vegetable kingdoms by analogy with the three primary circles of affinity, namely, "Animals being the typical circle, Vegetables the sub-Typical and Inanimate matter the Aberrant; which last is made up of three minor ones the endless modifications of Earth, Water and Air; each equally perfect, thus making together a series of five". All is well so far as the first stage in the subdivision whereby, for example, the exogens (or dicotyledons) are revealed as analogous with the vertebrates. Afterwards, however, "the Zoological system . . . seems to have gone far ahead of the Botanical" and even in the latest systems of Lindley and of Endlicher, which are briefly noted, no satisfactory quinary subdivision is attained for the primary exogenous and endogenous groups. To make good this deficiency, Wight then sketches out a provisional quinary classification of his own, using many of the Lindley and Endlicher class names. His groups, he says, "have a circular appearance and give promise that . . . their thorough investigation may put us on the right path and speedily enable us to reach the long and anxiously sought for goal". For Wight, "to discover these [circles], if they actually exist in Nature, appears in the present state of enquiry to be the first and grand desideratum towards the discovery of the true Natural System of plants".

While Wight was speculating on the logical advantages of the one true natural system of classification as revealing the orderly plan of the Creator, Freke was developing a system whereby the actual process of creation could have been effected. His ideas in the main appear to have been derived from Bichat (1771–1802), who postulated "that the life of the body is the outcome of the combined lives of the constituent tissues" (Sir William Dampier, "A History of Science", 3rd edn., p. 274). For these tissues, Freke infers an ultimate common origin in a primordial form, the "embryo of organic creation". He thus claims to be the original propounder of the doctrine of descent and stoutly maintains that it is he, and not Darwin, to whom credit for this doctrine should be given. In a short paragraph devoted to Freke in the historical introduction to the revised edition of the "Origin of Species", Darwin refers (p. 19) to "the difficult attempt to give any idea of his views"; indeed, not without reason, as will be demonstrated in the ensuing paragraphs.

Freke's earlier pamphlet is evidently a reprint of the circular mentioned by Darwin (*loc. cit.*), which was published originally in October 1860. It consists largely of quotations from the author's articles in the *Dublin Medical Press* of the years 1851–52, and in its present edition takes the form of a prospectus for his book "On the Origin of Species by Means of Organic Affinity", newly published in 1861. The title is an obvious counter to Darwin's work to which, he says, surely with studied under-emphasis, "My attention has, within the last few days, been directed by the merest accident . . .—a work, which as I have been given to understand, is at the present moment attracting a large share of public attention". His position is soon defined; following the review (presumably Bishop Wilberforce's) in the *Quarterly*, and with entire neglect of the principle of natural selection and the arguments upon which it is based, he quotes Darwin's statement that "Analogy would lead to the belief that all animals and plants have descended from some one prototype" as the sole point at issue. He "feel[s] it to be due, as well to myself as to science, to acquaint the physiological public that although that theory has now been reached through a different channel, it has not *now* been announced for the first time. *Nine years* before the appearance of Mr. Darwin's publication, I, as the

result exclusively of *inductive* inquiry, submitted this *identical hypothesis* to the judgment of physiologists —a conclusion which Mr. Darwin has since attained to by *analogy*".

The original announcement of the theory is supported by the first of the quotations from the *Dublin Medical Press* of November 1851. In this, Freke presents as an important subject of physiological inquiry the distinction between the organic world "*at the period of its creation*" and at "its present *advanced stage of development*". The second paragraph of the quotation is worth reproducing in full, with Freke's italics and parentheses:

"The line of investigation which (as it appears to me) should be pursued in such inquiry is the following—namely, I should endeavour to ascertain,—first, what is the constitution of organic creation as it *now* exists; or in other words, what is the constitution of the *present generation* of organised being? and secondly, how or *in what manner* has the present generation been *generated* or formed by the preceding generation? A knowledge of these two facts would (as I conceive) furnish us with data from which to collect a certain amount of information as regards the *necessary* constitution of the *origin* or (if I may venture to term it) of the *embryo of all generations*. For if the manner in which organised beings universally have been generated can be *accurately* traced back for *one* generation, there is nothing to prevent its being, with equal accuracy, traced back for *many*; and *the possibility* is that it may, with a certain degree of accuracy, be traced back *for all* generations; that is, in other words, till we have eventually arrived, in imagination, at (if I may so term it) the *embryo* of ALL organic creation".

Pursuing this inductive inquiry on the assumption that all individual living beings "*have been formed by the union of a number of minute organisms*", or "organizing atoms", he reaches the conclusion (at first sight almost a foreshadowing of the discovery of the linear arrangement of genes in the chromosome) that the "embryo of organic creation" consisted of "a chain composed of perhaps but a few individual microscopic granules".

Later in the same article, the nature of this chain of organizing atoms is further defined. Each atom is to be regarded as a "*distinct species of organizing matter*", with the common function, however, of indefinite self-regeneration through the process of imparting ever higher degrees of organization to the "organized residual products" of the atom beneath it in the chain, the lowest atom of all having as its substratum of activity "the unorganized or mineral world". The various "organizing atoms", by uniting in various ways, were supposed to constitute the "*first or earliest embryos*" of different plant and animal species, their "organized residual products" similarly combining to form "the various compound residual products required by Nature to enable those embryos to discharge their physiological function". "This, I say, appears to me to have been the origin of species by means of what I have ventured to term *organic affinity*". Freke is no believer in evolution in the Darwinian sense: he is concerned merely with the formation of "*the first generation* of living beings", not with any possibility of their subsequent modification by descent. Indeed, he is at pains to emphasize, beneath the title of his book, that "Nothing is advanced in this publication that is not perfectly in harmony with the Mosaic record of Creation".

So far, it is not difficult for the modern reader to find in Freke's "organizing atoms" and their products an analogy with his own concepts of genes, organization centres, etc.; but the author soon makes it clear that he has in mind categories of much more limited anatomical significance only. This is developed in the postscript to the above quotations and especially in the second of the two pamphlets, which is dated October 1862.

The heading of the second pamphlet (considerably shortened) runs:

"TABULAR VIEW of the relation . . . between the Three Kingdoms of Nature with regard to Organization; including that subsisting between Organiz*ing* Agents and Organiz*ed* Residual Products . . ., shewing at the same time the Circle of the same elementary components . . .; and pointing to the nature of the *dependency* of LIFE upon DEATH in both the Vegetable and the Animal Kingdom".

The pamphlet chiefly adds the names of the "organizing atoms"—*lignat, musculat, celebrat*, etc., with, rather surprisingly, *georgat* as the first of the vegetable series—"the simple germ (or atom) which organizes earth". Finally, the dependence of life upon death is illustrated by considering the difference between the plant and animal worlds, the "*organic life*" of plants involving merely the death (and simultaneous regeneration) of *organizing agents*, the higher form of "animal life" involving in addition a second species of death, namely the death of the *organized residual products*. As evidence of this, the indefinite increase in size of the plant body is contrasted with the fixed size of the animal. The views expressed in this second pamphlet are traced in part to an essay published in 1848 ("Freke on Organization"), in part to the article, already referred to, in the *Dublin Medical Press* of 1852.

Reading Freke's pamphlets, one cannot help but admire his apparent ingenuity and fertility of imagination, even while exasperated and amused in turn by the redundancy of his style. It is not for me to assess the originality of his ideas; but at least it is surprising to find him omitted from the "Dictionary of National Biography". Here, only "John Freke (1688–1756), surgeon" and "William Freke (1662–1744), mystical writer", find a place; and either, one feels, would have been an appropriate forbear.

That Robert Wight, no less than Darwin, found it difficult to deal with Freke's views is apparent from his manuscripts, which can now be described. The letters were written in Wight's retirement, presumably from Grazely Lodge, Berkshire, and from the internal evidence they can be dated to within the first fortnight or so of December 1862. Three out of the four can fairly easily be arranged in order: the first (about three hundred words, in pencil on the back of a seedsman's circular) is apparently a rough draft for the second (about 550 words) which, in turn, was expanded into the third (about a thousand words), written a week later. Of these, I propose to give extracts, making, so far as possible, a continuous narrative, the references in brackets (1–3) indicating the source of the material as described above. The fourth, which is unfortunately a fragment only (about three hundred words, on a half sheet of paper, apparently with a preceding portion torn away) is less easy to place; being in addition rather lighter and more personal in style as compared with the others, it may be quoted, almost in its entirety, as a fitting tailpiece to the series.

In the opening paragraph of (2) and (3) there is a reference to some earlier criticisms made by Wight, apparently well received. These perhaps related to the pamphlet(s), Wight being presented afterwards with copies of the author's books, as mentioned in the letter:

"My Dear Sir,

"I am ashamed to have to begin my letter with the confession that at least 10 days have elapsed since I had the pleasure of receiving your letter of the 22nd and the books which arrived the day after. I accept them with many [thanks] and hope we shall some future day have the pleasure of becoming better acquainted. I was exceedingly pleased to learn that my criticisms were so well received for, to tell you the honest truth, I was very fearful, when I read over for the last time what I had written, that on some points I had been much too severe and thought of either suppressing my letter altogether rather than hurt your feelings further after the strain to which they had already been put, or write the whole over. The latter alternative was out of the question so I determined to send it on, hoping for the best. Since happily you think the criticism was not really unjust and was written in a really friendly spirit let us bury the objectionable parts in the saying that ''tis all well that ends well'.

"Since the receipt of your volumes I have been reflecting a good deal on your and Mr. Darwin's views on the origin of species and right or wrong have arrived at a conclusion somewhat different from both. You say you have arrived at a conclusion 'as the result exclusively of *inductive* enquiry' which Mr. Darwin has since attained to by *Analogy*. In this statement I think you have fallen into an error. To my mind, induction is the process employed in both cases, with this difference, that the inductive process begins at opposite ends. He reasons backwards from the perfect plant and animal to the primordial germ, whereas you reason from the assumed germ onwards to the perfect animal. He says 'I cannot doubt that the theory of descent with modification embraces all the members of the same class. I believe that animals have descended from at most four or five progenitors and plants from an equal or lesser number'. That is the theory arrived at by induction. He then adds that analogy would lead one one step further, namely to the belief that all animals and plants have descended from one prototype: and adds that analogy may be a 'deceitful guide'* ; and then winds up by saying that he would infer from analogy that probably all organic beings that ever lived have descended from one primordial form *into which LIFE was breathed by the Creator*. His theory, then, rests on a persevering close induction carried on through 480 pages; the finale only is an Analogical inference. And that inference I think questionable.

"You, on the other hand, assume that the Creator imparted life to a germ which then went on multiplying itself and your induction, resting on that assumption, goes to show that such must be the case. The induction therefore, every step of which may be unquestionable, rests on a postulate which you can't prove. Darwin's, on the other hand, rests in the first instance on unquestionable facts, the known tendency of both plants and animals to form variations" (3).

Although the logic of Darwin's argument is thus favourably contrasted with Freke's, his conclusions are not thereby rendered acceptable. This is well brought out by reference to an earlier version, namely:

"Darwin being a laborious painstaking man and a deep very cautious thinker started on his course of investigation, which for twenty years he has never ceased to follow up, from certain undeniable data of every day occurrence among both Animals and Vegetables, their liability namely under certain circumstances to variation. Then, calling in the aid and experience of the breeder and gardener and allowing unlimited time he has as he supposes traced back organization to a point or at most a few points or monads or primordial germs or any other name you may prefer but still admits that these germ or germs must in the first instance have derived its vitality from a higher [? source]. Working on that idea for 20 or more years he has ransacked every source of information which he can directly or indirectly bring to bear on the subject and has made a very interesting book, heavy at times to read from his peculiar style, but to my mind lost labour for it leads to nothing, does not advance our knowledge of the origin of vitality and only claims for it powers which all our experience goes to disprove. . . ." (1).

* A quotation conveniently omitted by Freke.

A big stumbling-block is the apparent fixity of living species and the difficulty of envisaging modifications of the size demanded by the evolution theory. As Darwin puts it . . . "we are always slow in admitting great changes of which we do not see the steps".

"A grain of pollen the 100,000th part of an inch in diameter is placed in contact with the pistil of its own species and a great tree results; but apply the pollen of an Oak to the Alder or Pine or any other genus but its own and it fails to impregnate the ovum. This law holds throughout the whole vegetable kingdom . . .

"From this I infer that the Deity in creating organic germs, supposing that was his mode of proceeding, imparted to each its specific character, which, with some modification, it still retains; by which it is permitted to vary within certain limits. The Gardener produces floral varieties in any number but he can't change an apple into a pear nor a cherry into a plumb [*sic*]. The pigeon breeder can by selection and careful breeding obtain many varieties among the species of that genus but can't change a pigeon into a hawk, and won't the same law hold good through the whole of the organic kingdom? Specific variations are everywhere observable, but not transitions from one natural order or genus to another (2).

"It is difficult if not quite impossible with almost any stretch of the imagination, assisted even by myriads of years, to fancy such an unit as a Byssus becoming a lofty Palm, or a monocotyledonous grass an umbrageous oak" (3).

But the biggest difficulty of all, in accepting either theory, is the philosophical one: the element of chance is felt to play too great a part. Wight, as much as Freke, ignores completely the force of natural selection.

"Since reading Darwin's volume, I have thought much of his theory as summed up in the concluding page and with every wish to view it with a favourable eye I cannot bring [my] mind to accept it as a correct exposition of the Creator's plan in covering the earth [with] its organic inhabitants, vegetable and animal. We can in imagination conceive the deity imparting to certain atomic elements the force called life, enabling them to impart the same force to others of the same kind just as a spark falling among suitable materials will raise a great fire, but I cannot accept the idea that out of such materials—shapeless vitalized atoms—the wonderfully complex organisations each and all possessing the most perfect adaptation to its wants could ever have been derived without the aid and guidance [of] omnipotent power and inscrutable wisdom. From the first promulgation of the idea as deduced from Analogy my question has always been, what does Philosophy gain by its adoption? The aid of the Deity is required to set life in motion, why then limit his power to the mere giving of life, leaving it to circumstances to determine its forming a shapeless puffball or a man? (2).

". . . having required the aid of Omnipotence to organize our first atom it behoves us to return to the same source and solicit inscrutable wisdom to superadd those laws of combination and arrangement which we find prevailing throughout organic existence. . . . I go a step further and add that since the aid of the Deity is needed in the first instance to impart life and organisation, that organic philosophy gains nothing whatever—it may lose—by adopting the doctrine [of] the creation of a solitary primordial form—germ or atom, call it what you will—and leaving all the rest to secondary causes" (3).

To Wight then, 'organic philosophy' carried the day and the evolutionists were found wanting. The order and logic of the natural system with its quinary circles of affinity were perhaps more to his liking than

the ruthlessness of natural selection and the improbabilities of the "embryo of ALL organic creation". But at least the issue was not decided without much thought. Of all the four versions of the final verdict which have survived in these manuscripts, none is more characteristic than that which follows, in conclusion :

"... But I now find that were I to attempt extending my notes on the subject they would form quite an essay . . ., while my imperfect acquaintance with the science of the present day would to some extent disqualify them for publication in the state they flowed from my pen. As mere suggestions to help a master mind they might perhaps be useful, but scarcely otherwise. But be that as it may, I am not by any means satisfied in my own mind that either of you have attained the desired goal though you attempt to reach it by such different routes. He [*i.e.* Darwin] starts from the present time and by a rigid process of induction argues that nature commenced her existing animal kingdom by the creation of some 4 or 5 forms, her vegetable one by about as many primary vegetable forms thousands of years ago. Such is the process by which the patient and laborious Saxon goes to work. The rapid thinking and impulsive Celt on the other hand, having caught sight of his theory in the distance, straightway bounds to prove by induction that it must be right. While the cautious Scotchman looks first at the one and then at the other and right or wrong thinks both have missed the mark and concludes that Moses is the profoundest Philosopher of the three since he is content to take things as he finds them and in one word declares all we know or are ever likely to know by saying *God Created*, without enquiring how".

# STRUCTURE AND EVOLUTION OF THE LEVANT AND NORTHERN AFRICA

By Dr. K. S. SANDFORD
University Museum, Oxford

THE following notes are an attempt to recapitulate the essential stages in the development of the southern side of the western Tethys and of the Mediterranean. They refer particularly to Leo Picard's publications, especially "Structure and Evolution of Palestine, with Comparative Notes on Neighbouring Countries"*, from the point of view of the geologist who has some familiarity with north African problems. Much that is still in doubt and much of local significance must inevitably be omitted; nevertheless a broad review of this type may be useful at the present juncture.

At the end of the Pre-Cambrian, Palestine lay on the borders of a high (Upper Algonkian) mountain range in which earlier mountains and varied rock types were welded into a mountain mass: this may be traced from Arabia through Sinai and the Red Sea Hills into Africa ("Arabo-Nubian mass"). Pre-Palæozoic denudation reduced the mountains to a lowland with seas lying on the west and north, the latter being identified with an east-west Palæozoic sea. Marine Cambrian beds are recorded on the mainland mass of north-west Africa and of western Asia, and from the Cambrian to the Cenozoic there were far-reaching transgressions across Mauritania, the Sahara, Libya and Egypt into the interior of Africa, across Palestine into Arabia.

During regressive phases, widespread continental beds were laid down over areas formerly marine. As there was continuous subaerial denudation and accumulation over the land areas, stratigraphy there is concerned largely with the interdigitation of continuous and discontinuous subaerial deposits, lagoonal and marine beds. The shore-line, continually shifting, was frequently indented: the sea and its lagoons ran far into deep bays between promontories on which subaerial processes continued. The advances of the epicontinental seas might therefore be called, as Picard suggests, ingressions rather than transgressions. The major promontories were broadly related to swells or structural undulations, the locations of which in northern Africa are plainly marked.

The continental beds consist for the most part of dune-sands and fluviatile quartz conglomerates: similar beds are now accumulating in the continental interiors of Arabia and northern Africa. Nubian Sandstone is an unfortunate term for these beds, in my opinion; Nubian facies expresses all that is desired: Nubia (in a broad sense) and lands to the south of it have probably been continental since the Pre-Cambrian.

Palæozoic transgressions (or ingressions) occurred in Palestine and adjoining territories in the Middle Cambrian, Ordovician, Silurian, Lower Devonian (?) and Lower Carboniferous (Sinai and on the Egyptian side of the Gulf of Suez): the Silurian left graptolite-bearing shales in Central Arabia.

In northern Africa the Palæozoic transgressions, Cambrian, Ordovician, Silurian, Lower-Upper Devonian, Lower Carboniferous seem to have come from the west rather than the north. The Silurian graptolite-bearing shales can be traced far into the interior, where they pass into sandstones. In western Asia, as in northern Africa, the Carboniferous seems to have witnessed final Palæozoic regression. The Triassic palæography of Palestine was nevertheless related to that of the Palæozoic, with a shelf sea, transgressive from the nearly Tethys, in the Lower-Middle Trias, followed by Upper Triassic uplift and continental beds.

The north-western corner of the African shield, with its Palæozoic blankets, was involved in Hercynean mountain building, and Triassic (or Permo-Triassic) red beds with salt mark a stage in the ensuing denudation: except for small patches of lagoonal beds, the unfolded continental platform seems to be devoid of Triassic rocks.

In Sinai and Palestine there was renewed transgression of a Jurassic sea shallowing eastward: locally there are thick Bajocian – Kimmeridgian beds following a Lower Jurassic (Liassic) continental phase. Moreover, the uppermost Jurassic (Portlandian) beds appear to be regressive-continental, a condition which was maintained until Wealden (Lebanon – Palestine), Albian (Syria), or Cenomanian (Eastern Sinai–Transjordan) transgression supervened. The 'facies of the Nubian Sandstone' predominated during the regressive and transgressive phases; there was extensive volcanic activity and probably fracture in the transition from the Jurassic to the Cretaceous.

There is a small exposure of marine Jurassic beds on the Egyptian side of the Gulf of Suez; otherwise they do not seem to be exposed in Egypt, Libya or the Sahara: some continental beds are known in Libya, and probably there are others. A new element is discernible however, namely, the Mesozoic sea of

* Structure and Evolution of Palestine: with Comparative Notes on Neighbouring Countries. By Leo Picard. (Bulletin of the Geological Department, Vol. 4, Nos. 2, 3, 4.) Pp. iv+134. (Jerusalem: Geological Department, Hebrew University, 1943.)

Barbary, where thick Jurassic sediments, mostly limestones, followed the Trias: they represent sedimentation in a deepening sea which seems to have transgressed southward on to the platform of the Sahara only locally (Saharan Atlas, Tripolitanian coast). The Jurassic development of Barbary and of the northern Saharan fringe therefore differed from that of the Levant in certain particulars; in both there were ingressions accompanied by thick limestones, and between them continental north Africa was probably dry land.

Much uniformity is to be observed in Cretaceous development. Aptian – Albian transgression appears from north Sinai across Palestine to the Lebanon; southern Sinai and Transjordan were still continental, but the sea penetrated into them in the Upper Cretaceous, in part only in the Upper Cenomanian: it does not seem to have invaded the Arabian Central mass. The Upper Cretaceous dolomite is thick in Palestine, in western Transjordan the beds are thin and sublittoral; the Senonian – Maestrichtian being phosphatic and including abundant cherts. There was Upper Cretaceous vulcanicity in Transjordan.

In north Africa transgression was widespread from Egypt to the Atlantic, giving rise to shales, marls and limestones, and penetrating to the continental interior. In Egypt the Lower Cretaceous is slightly exposed only in the north, the Upper Cretaceous Cenomanian and Turonian transgressed farther to the south, and the Senonian – Maestrichtian includes the most southerly outcrops. Their littoral phosphatic beds can be traced eastward into Sinai, Transjordan and Syria and westward across the Libyan desert. Nubian facies and lagoonal deposits were developed over the continental surfaces near and inland of the Cretaceous shores. The history of Cretaceous transgression was broadly similar in Egypt, Libya, and the northern Sahara.

Similar conditions also obtained over the southern (Saharan) part of Barbary; but in the northern part (Tell Atlas), bathyal (Tethys) sediments accumulated.

The passage from Cretaceous to Palæogene introduces a number of small but important changes. In Palestine and adjacent territories sediments were laid down in deep bays bounded by land swells (bituminous chalk series): vertical movements therefore gave rise to gaps and discordances in Danian, Eocene and Oligocene beds. In two great north African embayments, Egypt – Libyan desert and Sirtica, Lower Eocene chiefly nummulitic limestones followed the Cretaceous, though the conformity between them is not perfect, and in the Tertiary gulf of Sirtica the Lower Eocene rests on Palæozoic and Mesozoic continental deposits. The Middle and Upper Eocene seas retreated northward to such an extent that the Oligo-Miocene shore line ran from the region of Cairo roughly westward nearly to Tripoli: the regions of the great Cretaceous – Lower Eocene shelf seas were land once more, with continental deposits of Nubian facies and notable cobble beds made of Eocene cherts.

Farther west, in the Sahara, end-Cretaceous regression was final: there was no major Eocene transgressive sea but only shrinking Algerian – Tunisian and western Moroccan bays with their valuable Cretaceous – Eocene phosphatic limestones. This marked dissimilarity with the east is associated with the convulsion of the Tethyan geosyncline and the creation, in part, of the Atlas mountain system, of flysch and bathyal deposits, largely at the expense of the northern shield rocks and their blankets of Mesozoic sediments; the bathyal Mesozoic beds of the geosyncline itself were also involved.

The movements responsible for the Cretaceous – Eocene disconformities, local and highly variable in their magnitude and significance between Saharan Barbary and the Levant, are no doubt related to that convulsion, but they are epeirogenic discordances, as Picard points out, remote from the geosyncline, devoid of a flysch facies; and their influence, mainly pre-Eocene, may also account for many changes of Mesozoic facies, both marine and continental.

In Palestine the rhythm of up-and-down movements was interrupted by a short-lived Lower Miocene (Burdigalian) phase of tangential folding, immediately succeeded by renewed uplift, extensive fracturing, block-movements, and some volcanic activity. Still greater uplift followed in the Pontian and in pronounced form at the end of the Pliocene. Picard remarks that the last of these transferred the Burdigalian fold-ranges into upwarp arches and downwarp basins. There is much that points to the Burdigalian of the Levant marking a major orogenic break between Palæogene and Neogene, the varied and thick inland deposits of which may be related to those of Iraq and adjacent territories. Already in Miocene times the fractures induced the formation of graben which, with the folding troughs, formed inland basins. Miocene to Pleistocene cycles of sedimentation took place in these basins, the tectonics of which, owing to the plasticity of their salt and gypsum, are complicated and of peculiar individuality.

The last major fracture phase in Palestine occurred between the Old and Middle Pleistocene and was accompanied by thick and widespread basaltic flows which have preserved large areas of the old land surface: movement has not yet ended. The Quaternary deposits of Palestine are therefore a legacy of the Miocene, and in the several distinct basins, especially that of the Jordan, their history can be traced in considerable detail.

On the Palestinian coast marine Neogene ingressions (Vindobonian, Astian) formed narrow embayments: there was no longer deep transgression over Transjordan. On the whole the Neogene, and perhaps the Oligocene, marked a great regression, with minor oscillations.

It is difficult at present to give an entirely satisfactory review of the north African Neogene development because much of it is still open to debate. It is well known that a much broken area lies between the Gulf of Suez and the Nile valley, in which certainly three directions of faulting may be recognized, in which also folded structures are prominent. Various interpretations have been put upon them: space forbids adequate discussion of a considerable controversy. Perhaps all that is vital and not controversial can be put in a few sentences. Oligo-Miocene or Burdigalian deposits both here and as far as Cyrenaica chronicle primarily destruction of the land by subaerial denudation: some of the beds may be marine, some fluviatile, and there are doubtless gaps in the sequence. Middle and Upper Miocene beds are mainly shallow-water marine limestones and marls. There were important Oligo-Miocene or Miocene basalt flows and sills. A conservative view of the fractures east of the Nile to Sinai is that they owe their origin to movement of blocks, that some of them are pre-Miocene, and that these made way for Miocene ingression, as in the Gulf of Suez, but that some of them are post-Miocene. Folds, some of them spectacular, may be related to bending induced

by faulting, but from eastern Egypt to the Libyan desert there are marked undulations running north-east – south-west across the broadly longitudinal swells. These remarks may apply in modified form to Cyrenaica. Between the Nile and Cyrenaica the country does not seem, on the whole, to have been so severely broken. West of Suez along the Egyptian coast fracturing probably ended before the Pliocene, or in its earliest stages. There was a period of great volcanic activity, of Tertiary to Recent age, in the interior.

Pliocene beds lie unconformably upon various Tertiary rocks. Important ingressions and regressions took place within the Pliocene itself, especially in Egypt, followed by lesser marine oscillations, finally recessive, in the Pleistocene.

From these facts, it may be implied that north Africa felt the repercussions of the Neogene upheavals in the geosynclinal Tethys, and reacted to them in a distinctive and recognizable manner. In Barbary the final stages of mountain building were enacted, accompanied by the exclusion of the Neogene gulfs from among the major mountain elements of the Tell. It was a long process, which contrasts sharply with the peculiar Burdigalian folding phase recognized in Palestine.

# OBITUARIES

## His Grace the Archbishop of Canterbury

THE death on October 26 of Dr. William Temple, Archbishop of Canterbury, was a sad blow not only to his intimates and his Church, but also to the rest of the nation and, indeed, the whole world. In the short two years of his primacy, Dr. Temple had earned and gained a unique place in the affection and regard of the people. Although erudite he was no dreary scholar; although deeply religious he was not sanctimonious; although a man of high standards he was charitable to others.

Much has been made in recent years of 'the conflict between science and religion', and the friction of this conflict has engendered more heat than light. The difficulty has been that so few men of science have understood religion, and most churchmen have been ignorant of science. William Temple bridged this intellectual gap and, perhaps even more important, bridged the gap in social intercourse. His years at Manchester and York gave him many opportunities to make contact with men and scientific organizations, and he made the most of them. His appreciation of science was well disclosed in his sermon in Manchester Cathedral before the Victoria University of Manchester during its jubilee celebrations in 1929. Then he emphasized the essential need for universities to foster scientific research alongside scientific training.

It was, however, since his translation to Canterbury in 1942 that Dr. Temple took the most active interest in the field of the social sciences. Especially valued was his help in the work of the Central Council for Health Education, of which he was president. His influence and prestige were invaluable, but he was no mere letter-heading. His conduct of the meetings of the Council was a model of chairmanship, and many passages were eased by his urbane humour and kindly wit.

Dr. Temple was truly a spiritual leader, but in the more everyday practical problems of human society he also took a leading part. He got, and helped others to get, at the roots of certain evils of social and industrial life. He realized that here were problems of the spirit, for the understanding of which a widespread general education is necessary before any attempt can be made at their solution. He held an important position in the Workers' Educational Association, being its president for sixteen years (1908–24). His very practical philosophy comes out in all his well-known books, but perhaps more than elsewhere in his Gifford Lectures of 1932–33 and 1933–34 on "Nature, God and Man", in which he pleaded for dialectical realism as opposed to the dialectical materialism of Marx. Onwards from then, and especially at the Malvern Conference, his sermons, addresses and writings convinced a wide public that the Church is not concerned with "another world" but is a strong social force in this. As *The Times* said: "he was a philosopher whose mind had been deeply given not only to classical studies but also to the problems of current thought".

Born in a bishop's palace, and educated at Rugby and Oxford, Dr. Temple yet was one of the common people. He towered above the rest of us, yet neither appeared himself to be aware of the fact nor did he make his fellows unduly conscious of it. Truly he was a leader of men.

## Dr. Dorothy Ashworth

DR. DOROTHY ASHWORTH, whose untimely death at the age of thirty-six occurred on October 4, was, we had assumed, one of our coming plant pathologists. Her work on plant rusts began at the Royal Holloway College after she graduated from there in 1929, and it was during her second postgraduate year that Dr. Holden, on a visit to the College, saw and appreciated her skilful and immaculate technique in the isolation of sporidia and her inoculations with single sporidia. She was, in the following year, awarded a research studentship at University College, Nottingham, and continued the work in Prof. Holden's laboratory. The next year found her working in the Cryptogamic Laboratory of the University of Manchester, and from there she passed to the laboratory of the Royal Horticultural Society's Gardens at Wisley as assistant mycologist. Her work has been characterized throughout by exceptional thoroughness and sincerity. Her modest, unassuming manner masked a critical approach, sound judgment and a firm opinion. Her composed demeanour covered a meticulous care of the material in her charge and a constant watchfulness. There was no impatience for results, no haste to publish. Her attitude was simply that of a student seeking the truth. Science can ill spare such a faithful servant.

E. M. BLACKWELL.

DR. ASHWORTH joined the staff of the Royal Horticultural Society at Wisley Laboratory in the summer of 1935 as assistant to the mycologist. Before this her work had been concerned with pure research on various rust fungi, but she quickly adapted herself to the practical problems of horticultural plant diseases, and besides continuing valuable studies on various fungus parasites, notably the *Antirrhinum* rust fungus, *Puccinia Antirrhini*, rendered valuable assistance in the experiments on methods of control of diseases in certain ornamental and crop plants.

She was an ideal research worker, with a highly developed scientific and practical outlook, skilful, industrious and with a distinct flair for laying out and arranging experiments. Her technique was meticulous and her caution in studying data and reaching conclusions made for the utmost reliability.

At Wisley the very varied advisory and routine work precludes full-time attention to long-range research problems, but Dr. Ashworth investigated many diseases, such as a rust of rhododendrons, *Chrysomyxa Rhododendri*, the winter killing of wall-flowers, etc., and in collaboration with the writer was each year engaged in various field experiments on the control of various diseases of fruit, vegetables and flowers, for example, blight on outdoor tomatoes, club root of brassicas. In all this the standard of her work was always of the highest.

In 1943 she began the most important problem of her career, for which she was ideally fitted by training and inclination. The Dominion botanist of Canada approached the Council of the Royal Horticultural Society with the request that the very large collection of *Berberis* species and hybrids at Wisley be used for testing their susceptibility to black stem rust of wheat, as this knowledge was important in considering the importation of such plants in the Dominion. Accepting this work, she quickly made progress and recorded infection of some twelve species of *Berberis* by the wheat rust fungus once considered to be restricted only to *B. vulgaris*. Her special knowledge regarding the germination of teleutospores and sporidial infection, and her instinct for applying the correct technique in this kind of work, will be missed.

Visitors to the Wisley Laboratory will remember her engaging manner, and the many horticulturists who knew her will regret this loss to the science of horticultural plant pathology.

D. E. GREEN.

# NEWS and VIEWS

## Nobel Prize for Physiology and Medicine for 1944: Prof. J. Erlanger and Dr. H. S. Gasser

THEIR many friends on this side of the Atlantic will have been delighted to hear of the award of the Nobel Prize for Physiology and Medicine for 1944 to Dr. Joseph Erlanger, formerly professor of physiology at Washington University, St. Louis, and Dr. Herbert S. Gasser, director of the Rockefeller Institute, New York. The award recognizes a fundamental advance in the analysis of the nervous system. Nowadays, amplifiers and cathode ray oscillographs are part of the standard equipment of the neurophysiologist; the passage of the waves of activity in the peripheral nerve fibres can be timed to the nearest ten thousandth of a second and followed through the networks of the central nervous system with the same accuracy. It is to Gasser and Erlanger that we owe the introduction of this precision. They were the first to make effective application of new electrical techniques, after the War of 1914–18. By 1922 their cathode ray records had shown an unexpected complexity in the 'action potential' of a nerve trunk, and soon after they were able to prove that this was due to different groups of nerve fibres conducting at different rates.

An analysis of the groups in various nerves held out the hope of a close correlation between the function of the nerve fibre and its size and rate of conduction. A rigid correlation cannot be made, but the careful search for it has advanced our knowledge in many fields; for example, that of the mechanism of pain, of reflex activity and of inhibition. Erlanger and Gasser's work has inspired a large and active school of neurophysiologists to whom its precision and critical insight have set a very high standard. Their collaboration at St. Louis was cut short by Dr. Gasser's appointment as professor of physiology at Cornell University, but was renewed in 1936 in their Johnson Lectures on the "Electrical Signs of Nervous Activity". These lectures form an impressive account of the development of a new branch of neurological research.

## *The Lancet*: Retirement of Dr. Egbert Morland

DR. EGBERT MORLAND, editor of *The Lancet*, has retired. Though thirty of his seventy years have been given to medical journalism, this was the third of his careers. Of a Quaker family, he took his B.Sc.(Lond.) from Owens College with first-class honours, and distinguished himself at St. Bartholomew's Hospital Medical College, winning the M.B. gold medal in physiology. But the series of junior hospital posts that should have led to consultant practice ended when, like many another house-physician of those days, he developed tuberculosis. In Switzerland he embarked on a second career: he took the Swiss federal diploma and the M.D. Berne, settled in Arosa, and became an expert in the disease he had overcome, writing a prize essay on sanatorium construction and many papers on tuberculin. The contentment of his trilingual practice, however, was destroyed in 1914. After relief work on the Marne, he came to London and called at *The Lancet*. The editor, Squire Sprigge, asked him to remain as his assistant, and in 1937 he succeeded to the editorial chair.

Dr. Morland's experience and talents alike fitted him to conduct a medical journal of international scope. He combines a taste for detail with a flair for essentials, and innumerable contributors have been grateful for his drastic sub-editing of their papers. By concentrating on the needs of the reader he has played no small part in bringing about the improvement evident of late years in the presentation of medical data. His editorial columns have been enlivened by an eager mind, always ready to reconsider even the most venerable hypothesis. Likewise his intense interest in social and medical reforms has arisen from the needs of people, never from theories. Having found *The Lancet* humane, he leaves it human. He was elected a fellow of the Royal College of Surgeons in 1936 and of the Royal College of Physicians in 1941.

## Prof. A. G. Pugsley, O.B.E.

DR. A. G. PUGSLEY has been appointed to the chair of civil engineering in the University of Bristol formerly held by Prof. J. F. Baker, who was appointed in 1943 to succeed Prof. C. E. Inglis at Cambridge. Prof. Pugsley was educated at Rutlish School and Battersea Polytechnic, and graduated with first-class honours in engineering in the University of London in 1923. After serving as a student-apprentice in civil engineering at the Royal Arsenal, Woolwich, he was appointed a junior technical officer for design and research work at the Royal Aircraft Establishment Works, Cardington. In 1931 he transferred to the Royal Aircraft Establishment as a scientific and technical officer, where he is now the head of the structural and mechanical engineering department. In 1938 he was awarded the degree of D.Sc. of the University of London. He is a member of several sub-committees of the Aeronautical Research Committee and of the Ministry of Production. Dr. Pugsley has made notable contributions to engineering science, particularly in connexion with the structural design of aircraft and airworthiness, and the aero-elastic problems involved.

## British Non-Ferrous Metals Research Association: Mr. G. L. Bailey

THE British Non-Ferrous Metals Research Association has appointed Mr. G. L. Bailey as director to succeed Dr. H. Moore who has retired (see *Nature*, October 14, p. 482). Mr. Bailey graduated in metallurgy at the University of Birmingham, where he was awarded the degree of M.Sc. in 1922 after completing two years research work. During 1922–30 he was on the staff of the Research Department, Woolwich, where he carried out research on a variety of problems in non-ferrous metallurgy. During this period his most notable work was on the casting of 70/30 brass ingots for subsequent rolling, the results of which were published in association with Dr. R. Genders by the British Non-Ferrous Metals Research Association in a monograph "The Casting of Brass Ingots".

In 1930 Mr. Bailey resigned from the Research Department at Woolwich to accept the appointment of development officer of the British Non-Ferrous Metals Research Association. In this post he was responsible for fostering the application of the results of the Association's researches in industry. He played, however, a wider part in the Association's organization and in January 1942 became deputy director. Mr. Bailey is a vice-president of the Institute of Metals and chairman of the London Local Section of that body.

## Lister Memorial Lecture of the Society of Chemical Industry

THE first Lister Memorial Lecture of the Society of Chemical Industry will be delivered by Sir Alexander Fleming in the Anatomy Lecture Theatre, University of Edinburgh, on November 9 at 5.30 p.m. The subject of the address will be "Antiseptics". Under the auspices of the Society of Chemical Industry, endowed memorial lectures have recently been founded in different parts of Great Britain to perpetuate the memory of scientific men and industrialists whose work has assisted in building up the chemical industry. The name of the late Lord Lister has been chosen for commemoration in the Edinburgh and East of Scotland Section of the Society on account of his connexion with Edinburgh and because of the stimulating effect his revolutionary medical methods had on the growth of the fine chemical industry in Great Britain. The endowment has been the gift of two Edinburgh pharmaceutical chemical manufacturers, Messrs. J. F. Macfarlan and Co. and Messrs. T. and H. Smith, Ltd. The lecture will be delivered every four or five years in Edinburgh, Aberdeen or St. Andrews.

## Research on Tsetse Fly and Disease

THE Secretary of State for the Colonies has appointed a committee to consider and advise on the co-ordination of action, including research, directed against human and animal trypanosomiasis, and, in particular, against the tsetse fly as the chief vector. The committee, on which the Dominions Office and the Sudan Government are represented, will report from time to time to the Secretary of State for the Colonies, and on all matters affecting research its recommendations will be referred to the Colonial Research Committee for comment and advice before submission to him.

The committee is composed as follows: Mr. G. H. Creasy (chairman), Colonial Office; Sir Robert Archibald, representative of the Sudan Government; Prof. P. A. Buxton, London School of Hygiene and Tropical Medicine; Dr. H. Lyndhurst Duke, lately director of the Human Trypanosomiasis Institute in Uganda, and chairman of the League of Nations Sleeping Sickness Committee; Mr. S. A. Goulborn, Dominions Office; Prof. I. M. Heilbron, Imperial College of Science and Technology; Dr. E. M. Lourie, Liverpool School of Tropical Medicine; Sir Guy Marshall; Dr. S. A. Neave, director of the Imperial Institute of Entomology; Mr. G. F. Seel, Colonial Office; Dr. A. G. H. Smart, medical adviser to the Secretary of State for the Colonies; Mr. John Smith, adviser on animal health to the Secretary of State for the Colonies; Dr. H. A. Tempany, agricultural adviser to the Secretary of State for the Colonies; and Mr. C. W. F. Footman (secretary), Colonial Office.

## Cinemicrography

Two complementary papers dealing with cinemicrography were given at a meeting of the Association for Scientific Photography on October 14. Mr. H. Emmett described the apparatus used in one of the I.C.I. research laboratories, consisting of a petrological microscope, above which is supported the cine camera without its lens, while the microscope is also used without the usual eyepiece, but with a viewing attachment to enable the image to be kept under observation while being filmed. Focus on the film is ensured by inserting a piece of ground glass in the gate and balancing this image with the one seen in the viewing eyepiece; careful centring of the light is obviously of first importance. A 9·5 mm. camera was used connected through a belt drive to an electrically controlled gramophone motor which enables exposures to be taken at known intervals. Mr. Emmett showed films illustrating crystal growth, such as the change in crystalline form induced by the presence of impurities, the allotropic change in acicular crystals of ammonium nitrate which can take place on lowering the temperature, and the concentration gradient around a crystal during growth.

The second paper, by Mr. R. McV. Weston, entitled "Cinemicrography in Biological Research" dealt with similar problems but described a more elaborate

apparatus for higher power micrography and using a 16 mm. Cine-Kodak Special camera to record the images. Owing to the employment of living specimens, a rotating sector shutter was used to prevent overheating and the whole of the microscope stage was enclosed in an incubator, the necessary controls being outside. The heating elements were two 30-watt carbon filament lamps shielded to prevent direct rays reaching the object and a chloroform-mercury thermostat next to it. As in the first apparatus, the light was provided by a 100 c.p. Pointolite lamp. Mr. Weston showed a film of the movement of the leucocytes among the red corpuscles of the blood, and higher magnifications showed very clearly the triple nuclei.

## Electrical Accidents

IN a memorandum (*J. Inst. Elec. Eng.*, **91**, Pt. I, No. 43; July 1944) which assesses electrical accidents in relation to other accidents, and includes an appraisement of some electrical fire statistics, the published statistics of fatal accidents in Great Britain are analysed and the proportion of those of electrical origin are assessed in their relationship to the whole with special consideration of those occurring on domestic premises. Certain statistics concerning fires attributed to electrical causes in both domestic and industrial premises are studied, and the contributing factors are analysed in the order of their importance. It is concluded that electrical accidents have shown no significant increase in relation to the increased use of electricity. The number of fatal accidents due to defective installations tends towards a very low figure; but increasing attention should be given to the quality and maintenance of flexible connexions of the portable appliances employed in domestic situations and to the design and maintenance of the appliances themselves.

Statistics on the incidence of electrically caused fires are not adequate and do not give precise information on the primary causes of such fires. It appears that some 35 per cent of all fires attributed to electrical causes arise from faults in the fixed installations; but of the total fires attended, only 1·7–3·5 per cent are attributable to installation defects. The figure for domestic and similar premises is deemed to be lower than this, while the effect of improved techniques, the elimination of D.C. supplies, the use of new materials, and the provision of installations integrally planned in relation to other services in the structure, will all tend to produce a further reduction in the risks. A study of the commoner causes of fires indicates that, in addition to an expected decline in electrically caused fires in proportion to the utilization of electricity, a substantial decrease in the total number of fires is likely to occur as electricity supplants other fuels as a means for space-heating, water-heating and cooking.

## Royal Society of Edinburgh : New Officers

AT the annual meeting of the Royal Society of Edinburgh held on October 23, the following officers were elected: *President*, Sir William Wright Smith; *Vice-Presidents*, Prof. T. H. Milroy, Sir John Boyd Orr, Dr. A. W. Greenwood, Prof. E. Hindle, Dr. D. Russell, Prof. R. J. D. Graham; *General Secretary*, Prof. J. P. Kendall; *Secretaries to Ordinary Meetings*, Prof. W. M. H. Greaves, Prof. A. Holmes; *Treasurer*, Sir E. M. Wedderburn; *Curator of Library and Museum*, Dr. J. E. Mackenzie; *Councillors*, Mr. Stanley Cursiter, Dr. Douglas Guthrie, Prof. J. W. Heslop Harrison, Mr. A. W. Young, Prof. E. T. Copson, Lieut.-Colonel W. F. Harvey, Prof. A. E. Trueman, Prof. J. Walton, Prof. T. Alty, Mr. J. Morrison Caie, Sir Robert Muir, Sir David K. Murray.

## Announcements

THE Joint Committee of the Royal Physical Society, the Royal Scottish Geographical Society and the Royal Society of Edinburgh has awarded the Dr. W. S. Bruce Memorial Prize (1944) to Lieut. T. H. Manning, R.C.N.V.R., for his valuable survey and biological work during 1931–39 in Iceland, Lapland, Southampton Island, Hudson Bay and at Foxe Basin (1936–39).

AFTER the liberation of Paris, the secretary of the British Association was enabled, through the courtesy of M. Louis Rapkine, of the Mission scientifique française en Grande-Bretagne, to address a letter of goodwill to Prof. A. Verne, secretary-general of the French Association for the Advancement of Science. A message of greeting and hope for the early renewal of active relations between the two Associations has now been received by the Council of the British Association from Prof. Verne on behalf of the president and bureau of the French Association.

DR. A. N. MAY, lecturer in physics at King's College, University of London, has been appointed as from October 1 to the University readership in physics tenable at King's College. Since 1942 Dr. May has been on war service with the Department of Scientific and Industrial Research.

The following doctorates have been conferred by the University of London: D.Sc. on C. N. Acharya, Rothamsted Experimental Station; A. L. Green, King's College; Miss L. E. Hawker, Imperial College of Science and Technology. D.Sc.(Econ.) on B. R. Misra, London School of Economics.

THE following appointments have recently been made by the Colonial Office: R. J. Dewar and J. G. McQuillen, to be assistant conservators of forests, Nigeria; K. W. Aspinall, to be veterinary officer, Tanganyika; J. J. Steyn, to be entomologist, Uganda; J. N. Clothier and R. H. Fraser, agricultural officers, Northern Rhodesia, to be senior agricultural officers, Northern Rhodesia; D. F. Macpherson, veterinary officer, Kenya, to be senior veterinary officer, Kenya.

AN exhibition of historic scientific instruments and books, drawn from the collection which Mr. R. S. Whipple is presenting to the University of Cambridge, will be held in the East Room of the Old Schools during November 4–11. The exhibition will be opened by Sir Henry Dale, president of the Royal Society, on November 4 at 2.45 p.m., and will remain open on weekdays from 10 a.m. to 5 p.m. Admission is free. It is intended that the Whipple Collection shall form the nucleus of a museum of the history of science in the University.

PROF. J. HADAMARD will be unable to give the lecture announced for the annual general meeting of the London Mathematical Society on November 16. Prof. S. Mandelbrojt will give a lecture "On the Regularization of Sequences". It is hoped that Prof. Hadamard may be able to lecture at a later meeting.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Fetuin, a New Globulin Isolated from Serum

DURING a study on the fractionation of serum with ammonium sulphate, I thought it worth while to try whether some of the serum proteins could be isolated more easily from the serum of a newly born animal. Serum from calves not more than two weeks old was used for these fractionation experiments, which immediately indicated a pronounced difference between the serum from the calf and that from the cow. Ultracentrifugal examination of the different fractions revealed the presence of large amounts of a globulin with the sedimentation constant, $s_{20}$, of the order $3S$ ($1S$ (Svedberg) $= 1 \times 10^{-13}$ C.G.S.) as compared with the normal $s_{20} \sim 7S$ for serum globulin. The main part of the new protein was precipitated between the salt concentration limits 0·37 and 0·45 saturated ammonium sulphate. It was purified further by fractionation with ammonium sulphate and centrifugation in a high-speed air-driven centrifuge. Molecular weight determination gave a value of the order 50,000[1].

Experiments with serum from calves of different ages have shown that the amount of this globulin has its highest value in the newly born calf, and decreases with time. In the adult cow, its presence may be demonstrated in the fractions which correspond to those from the newly born calf where the new globulin is the predominant component. It seems reasonable to assume that the concentration of the new protein shows its maximum value in the fœtus and that it is in some way associated with the period when the greatest building and development of the animal takes place. I therefore propose that this new protein be called 'fetuin'. The name is derived from the Latin name for fœtus, namely, *fetus*.

Later experiments with fœtal sera from cow and sheep have shown that the 'total globulin' obtained from these liquids mainly consists of fetuin, whereas the presence of ordinary globulin with $s_{20} \sim 7S$ can just be demonstrated. Serum from human umbilical blood was also examined, but its contents of fetuin was only a few per cent. The same serum, however, contained considerable amounts of globulin with $s_{20} \sim 7S$. A similar result was obtained with rabbit fœtal serum, whereas foal serum behaved similarly to that from the calf.

The same grouping of the species (cow, horse and sheep on one side, and man and rabbit on the other) is found in one of their immunological properties. Thus placental transmission of antibodies takes place in the latter group, while the newly born animal of the former group receives its antibodies with the colostrum, when it is suckled for the first time (see ref. 2). There is also a distinct difference between the two groups in the construction of the placenta. In the case of ruminants, the placenta consists of three layers of cells, whereas in rodents and man the maternal blood is separated from the fœtal by only a single layer of cells.

It is still an open question whether or not fetuin is generally present in embryonic serum. In this connexion, it is of interest to note that Svedberg and Andersson[3] several years ago, in an unpublished investigation, found that no component with $s_{20} \sim 7S$ was present in serum from chicken embryo after 11–15 days incubation. The 'albumin peak' in the sedimentation diagram, however, was very asymmetrical and gave comparatively low values for the sedimentation constant. The low value for $s_{20}$ in this case may perhaps be explained by the possible presence of fetuin in the embryonic serum. After 18 days of incubation the globulin amounted to 22 per cent of the protein, and the 'albumin peak' had become more symmetrical.

Differences between hæmoglobins from adult and from fœtal blood have been reported from time to time, and it was generally supposed that they were to be found in the protein moiety of the molecule. Several years ago, G. S. Adair[4] found that maternal and fœtal hæmoglobin from sheep could be easily distinguished in electrophoresis. Quite recently, Wyman *et al.*[5] have demonstrated great differences in the solubility of maternal and fœtal hæmoglobin from the cow. At the same time, Andersch *et al.*[6] showed that the electrophoretic mobility is not the same for hæmoglobin from a newly born infant as that from an adult. The two sedimentation constants were also unlike ($s_{20} = 2·5S$ for the infant and $4·7S$ for the adult).

It is thus evident that in the case of the respiratory proteins and also in the serum proteins, great differences exist between their properties in the embryonic state and in the adult animal. This investigation is being continued, and details will be published elsewhere.

KAI O. PEDERSEN.

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University, Uppsala.

Sept. 13.

[1] Pedersen, K. O., in "The Svedberg 1884 30/8 1944" (Uppsala: Almqvist and Wiksell, 1944), 490.

[2] Kuttner, A., and Ratner, B., *Amer. J. Dis. Child.*, **25**, 413 (1922).

[3] Svedberg, The, and Andersson, K. I. J., private communication.

[4] Cf. Tiselius, "The Harvey Lectures" XXXV, 1939–1940, 67.

[5] Wyman, J., Rafferty, J. A., and Ingalls, E., *J. Biol. Chem.*, **153**, 275 (1944).

[6] Andersch, M. A., Wilson, D. A., and Menten, M. L., *J. Biol. Chem.*, **153**, 301 (1944).

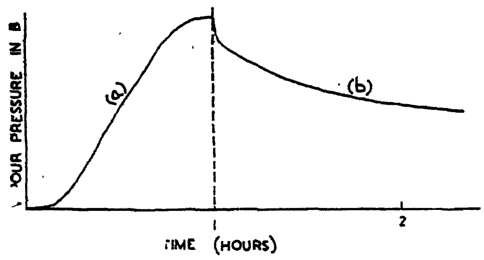
## Permeability of Keratin Membranes

BARRER[1] has suggested that the diffusion of vapours through media in which sorption and swelling occur are governed by a generalized form of Frick's Law, in which the diffusion constant is a function of the vapour concentration in the specimen.

Recent measurements in these laboratories of the diffusion constant of water vapour in keratin have provided an example of this phenomenon. At water contents below 6 per cent on the dry weight, the diffusion constant becomes extremely small in comparison with its value at higher concentrations.

This property of keratin may be demonstrated very simply as follows. Two compartments $A$ and $B$, separated by a film of horn a few thousandths of an inch thick, are both evacuated. Then on introducing water vapour into $A$ the subsequent rise in pressure in $B$ follows Curve $a$. The diffusion is slow until the film acquires a water content of about 6 per cent throughout, when a rapid increase in transport occurs, despite the decreasing pressure difference across the membrane, because of the large increase in the diffusion constant.

If, after equilibrium is attained, the water vapour is rapidly removed from $A$, the fall in pressure in $B$




becomes extremely slow after an initial rapid drop (Curve $b$). This is clearly due to a decrease in the water content on the side of the film adjacent to $A$, to a value below 6 per cent, which opposes the attempt to reduce the pressure in $B$ by the rapid evacuation of $A$.

This phenomenon may be common to all such absorbing films. Sir Charles Martin informs me that attempts to increase the rate of evaporation of liquid water through a collodion film by forced air circulation always lead to a decrease in the rate of evaporation as compared with that in still air.

G. KING.

Wool Industries Research Association,
Torridon, Headingley,
Leeds, 6.
Oct. 4.

[1] "Diffusion in and through Solids" (Cambridge University Press).

## Variations in the After-Glow Brightness of Active Nitrogen Under Varied Experimental Conditions

LORD RAYLEIGH, in a remarkable series of experiments, has studied photometrically the variations in the after-glow brightness of active nitrogen under varied experimental conditions. The results are of extreme importance in testing the various theories of active nitrogen. In the present note, some of these results will be considered in the light of the hypothesis recently proposed by me[1,2], namely, that active nitrogen is simply the ionized nitrogen molecule in the $N_2{+}\,(X')$ state produced by the discharge. If the walls of the vessel are suitably 'conditioned' to prevent the surface from acting as catalyst, the recombination of the positive ions with electrons proceeds mainly in the volume of the gas by a three-body collision process in which neutral nitrogen molecules act as the third body.

The experimental results discussed are as follow:

(1) The intensity of the glow in a vessel in which the active material is lost largely on the walls of the vessel falls exponentially with time $t$; the time required for the intensity, at any stage, to fall to its half-value is constant[3]. This is a characteristic of a unimolecular reaction. (The walls of the experimental vessel were 'poisoned' with Apiezon oil.)

(2) The intensity of the glow in a vessel in which the active material is lost mainly in the volume of the enclosing vessel varies inversely as $t^2$. This is a characteristic of a bimolecular reaction[4]. (The walls of the vessel in this case were coated with metaphosphoric or strong sulphuric acid to prevent surface reaction.)

(3) If the glowing gas is compressed, the intensity of the glow increases as the cube of the concentration[5]. This is a characteristic of a termolecular reaction.

(4) If the temperature of the glowing gas be lowered keeping the pressure constant, then, making allowance for increase of intensity due to increased concentration, the reaction-rate is found to have a negative temperature coefficient; it increases with the decrease of temperature[6].

To explain (1) we note that the recombination on the walls proceeds as follows. The electrons, on account of their higher velocity (due to smaller mass and to higher 'temperature'), arrive first on the surface (the 'poisoned' parts of it) and remain there as surface charge. The positive ions then arrive and become neutralized, giving up the energy of recombination to the glass walls. The poisoned or active parts of the glass thus play the part of the third body. The reaction-rate at any instant is obviously proportional to the active area and to the number of positive ions colliding with it per second. Since the active area remains constant, the number of recombinations is simply proportional to the rate at which the positive ions collide with the wall per second, and this in its turn is proportional to the density of $N_2{+}$ ions in the volume. The positive ion density and the reaction-rate thus fall exponentially with time, which gives the law of decay for a unimolecular reaction.

To explain (2) we recall that according to J. J. Thomson[7] the coefficient of recombination of electrons and ions ($\alpha$) by three-body collision is given by $\pi d^3u/\lambda$, where $d = 2e^2/3kT$ is the minimum distance of approach for the electron and the ion for effective three-body collision, $T$ is the electron temperature, $u$ the mean velocity of agitation of the electrons and $\lambda$ the mean free path—or rather, the mean energy free path—of the electrons. Now, the reaction-rate in the volume (temperature and pressure remaining constant) is given by $\alpha n^2$, where $n$ is the electron or positive ion density, assuming the two to be the same. From the expression for $\alpha$, we note that it is independent of $n$. The reaction-rate at any instant is thus proportional to $n^2$ and this explains the observed characteristic of the bimolecular reaction.

To explain (3), note that the reaction-rate $\alpha n^2$ is equal to $(\pi d^3u)n^2/\lambda$. When the glowing gas is compressed as a whole, the electron-ion concentration $n$ varies directly, and the energy free path $\lambda$ varies inversely, as the pressure. The reaction-rate, and hence the brightness of the glow, increases as the cube of the compression, which is a characteristic of a termolecular reaction.

To explain the negative temperature coefficient (4), note that in the expression for $\alpha$, $\lambda$ is independent of $T$, $d$ varies inversely as $T$ and $u$ varies directly as $\sqrt{T}$. $\alpha$ and, therefore, the reaction-rate, will vary as $T^{-5/2}$ (the concentration remaining constant). The hypothesis therefore predicts a negative temperature coefficient of the reaction-rate, as observed by Rayleigh. The calculated coefficient, however, appears to be much higher than the observed coefficient $T^{-0{\cdot}64}$. (In Rayleigh's experiment a part of the observation vessel—a tube attached to it—was cooled while the pressure remained constant. The increase of intensity due to increased concentration was allowed for in computing the coefficient. The observed coefficient was for the extreme range of temperature investigated, 90°–373° Abs.)

The discrepancy is explained if it is remembered that the temperature $T$ in the expression for $\alpha$ refers to the electron temperature and not to the molecular temperature. It is the latter temperature, however,

that was used in computing the coefficient; we do not know how the electrons in the observation tube were affected by the temperature variation of the medium surrounding it. It can, however, be safely assumed that on account of the high initial value of the electron temperature, its percentage variation was much less than the percentage variation of molecular temperature. The temperature coefficient computed by taking the molecular temperature is therefore necessarily smaller than the true coefficient. (It is to be remembered that J. J. Thomson's expression for $\alpha$ has not been tested for the pressures such as are ordinarily encountered in discharge tubes, and it is doubtful if the formula is strictly applicable to such cases, particularly because of the uncertainty regarding the energy free path $\lambda$. Nevertheless, the formula can be assumed to give, at least qualitatively, the nature of the variation of $\alpha$ with temperature, pressure and concentration).

S. K. MITRA.

Wireless Laboratory,
University College of Science,
92 Upper Circular Road,
Calcutta. Sept. 14.

[1] Mitra, S. K., *Science and Culture* (Calcutta), **9**, 49 (1943); **10**, 133 (1944).
[2] Mitra, S. K., *Nature*, **154**, 212 (1944).
[3] Rayleigh, Lord, *Proc. Roy. Soc.*, A, **151**, 567 (1935).
[4] Rayleigh, Lord, *Proc. Roy. Soc.*, A, **176**, 1 (1940); see data in p. 5; see also ref. 3, p. 576.
[5] See ref. 4, p. 10.
[6] See ref. 3, p. 13.
[7] Thomson, J. J., *Phil. Mag.*, **47**, 337 (1924).

## Borax as a Standard Buffer Solution

USERS of glass electrodes frequently require for purposes of standardization an easily prepared buffer solution in the region of $p$H 9, and use is generally made of an $M/20$ solution of A.R. borax, which according to tables[1] has a value of 9·23 at 20° C.

In the investigation of small errors in glass electrodes, it was found that the $M/20$ borax solution gave results which were invariably lower than the accepted values by about $p$H 0·05, and it was thought that these irregular results should be investigated as other workers might find similar difficulties in correlating data.

Samples of A.R. grade borax, made by reputable manufacturers, were first used, but it was found that when the solutions were prepared under the same conditions the results were uniformly low, indicating that the irregular results were not apparently due to methods of preparation of the material.

It has been stated[2] that $M/20$ borax solution has a $p$H value of 9·18 at 25° C. when the salt is treated so that it has the correct state of hydration, and as a check on this point a sample of borax was dehydrated to avoid errors of hydration. The $p$H value of an $M/20$ solution of the salt so prepared was $9{\cdot}13_2$ ($9{\cdot}17_2$ at 20° C.), which is still below the correct value.

A second sample was now prepared by dissolving the salt in boiling water to which sodium hydroxide was added to neutralize any possible traces of free boric acid. The salt was recrystallized from this solution and again recrystallized twice from distilled water. The product of each crystallization was filtered under vacuum and washed with distilled water. The final product was dried between filter paper in the air. A solution $M/20$ in strength was used for the test.

All the $M/20$ solutions were prepared from distilled water boiled in a 'Pyrex' flask and cooled with a soda-lime tube absorber for carbon dioxide. The $p$H measurements were made with hydrogen and calomel electrodes kept at constant temperature for 24 hours previous to the tests. Under these conditions the calomel cell has been found to give potentials in agreement with those given by Michaelis[3], and as a check an $M/20$ potassium hydrogen phthalate solution ($p$H 3·97) was tested. This showed the calomel cell had a potential correct to within 0·2 millivolt of Michaelis' values, and all readings of the various tests on the borax solutions were steady to 0·2 millivolt.

| Hydrogen electrode ° C. | Calomel electrode ° C. | E.M.F. mV. | $p$H | $p$H reduced to 20° C. |
|---|---|---|---|---|
| 20·2 | 20·5 | 782·6 | $9{\cdot}18_2$ | $9{\cdot}18_0$ |
| 20·8 | 21·2 | 782·6 | $9{\cdot}17_0$ | $9{\cdot}17_6$ |
| 21·0 | 21·2 | 782·8 | $9{\cdot}17_7$ | $9{\cdot}17_5$ |

From a long series of tests extending over several years, it has been found that the temperature coefficient of the $M/20$ solution of borax as given by Walbum[4] is quite correct even though the absolute $p$H value differs from his figures somewhat.

The $p$H values at 20° C. are computed on the basis of Walbum's figures, and rounding them off to the nearest $p$H 0·01, which is the limit of accuracy of ordinary $p$H measurements, it would seem that a value of 9·18 for an $M/20$ solution of $Na_2B_4O_7 . 10\,H_2O$ made up with carbon dioxide-free distilled water represents the more correct figure than 9·23 usually given.

It is difficult to offer any explanation of the discrepancy, since the original figures given by Walbum were presumably made with a hydrogen electrode. The value of 9·18 at 25° C. quoted by Hitchcock and Taylor[1] may have been based on a value of $p$H $4{\cdot}00_5$ for $M/20$ potassium hydrogen phthalate. Reducing their figure to the more usual value of 3·97, this gives 9·15, which is still $p$H 0·02 above the value usually found, a small but very definite discrepancy. It would be interesting to learn other workers' opinions on this point.

A. D. ELMSLY LAUCHLAN.

Cambridge Instrument Co., Ltd.,
47 Sydney Road,
London, N.10.
Sept. 22.

[1] "Hydrogen Ions". By H. T. S. Britton.
[2] Hitchcock, D. I., and Taylor, A. C., *J. Amer. Chem. Soc.*, 1812 (1937).
[3] Michaelis, L., "Die Wasserstoffionenkonzentration".
[4] Clark, W. M., "The Determination of Hydrogen Ions".

## Identification of the Montmorillonite Group of Minerals by X-Rays

THIS group of clay minerals (referred to hereafter for brevity simply as "montmorillonite"), which is often found in soil clays, fuller's earth and bentonite, is characterized by the variation of the position of the basal reflexion, on an X-ray powder or aggregate diagram, from about 10 to about 18 A., according to the state of hydration[1]. The minerals of the group are notoriously difficult to identify positively from a single X-ray diagram because ($a$) the line at 14 A., which is given by montmorillonite in a normal state of hydration, is liable to be confused with a basal

reflexion from chlorite or vermiculite, both of which might occur in soil clays; and (*b*) the basal reflexion may be diffuse, due to the simultaneous occurrence, in the crystallites, of two or more different basal spacings.

The former difficulty has been mentioned by Nagelschmidt[2], who recommends taking photographs of the clay at different stages of hydration, as a means of surmounting it; and the latter has been discussed in several papers by Jackson and co-workers[3], who have recommended a special procedure for the controlled hydration of montmorillonite, which they claim ensures a sharp reflexion at about 16 A. If these recommendations are to be followed, the procedure necessary for the mere identification of montmorillonite in clays will clearly be complicated and time-consuming.

For this reason, it seems worth while to direct attention here to a very simple and apparently quite unambiguous method which I have been using for some time for the purpose. It depends on the observation (made during some as yet unpublished research on the effect of absorption of alcohols on the montmorillonite lattice) that when montmorillonite is treated with glycerol, a very sharp and intense first-order basal reflexion is obtained at about 17·7 A., as well as a number of higher orders. The line at 17·7 A., being well separated from any lines due to other likely minerals, is very suitable for identification. All that is necessary is to add glycerol to a clay suspension at the rate of about one drop to each 80 mgm. of clay, and then evaporate to dryness. The latter operation may safely be completed on a steam bath or in a desiccator. This technique may be combined with Nagelschmidt's aggregate technique[4] by adding the right amount of glycerol to the clay suspension which is to be used for forming the aggregate.

From tests which I have carried out, it appears that the following advantages may be claimed for this method.

(1) *Wide applicability*. The method has been tried so far on montmorillonites from fuller's earth and bentonite, on nontronite, on Hector clay (octophyllite montmorillonite), and on a number of soil clays containing montmorillonite, and has given essentially the same result in all cases, at any rate so far as the first order of the basal reflexion is concerned. The ratios of the intensities of the different orders of the basal reflexion probably vary somewhat in the different types of montmorillonite minerals; but this is not very important from the present point of view.

(2) *Great sensitivity*. In a test to discover the minimum quantity of montmorillonite in a mixture which can be detected by this method, using kaolin as diluent, it was found that 1 per cent of montmorillonite gave a visible 17·7 A. reflexion on an aggregate diagram.

(3) *Insensitivity to hydration conditions*. Samples which were (*a*) dried on a steam bath, (*b*) dried over phosphorus pentoxide at room temperature, and (*c*) allowed to stand over water for a week at room temperature gave essentially the same powder diagram. In particular, the position of the 17·7 A. reflexion seemed to remain quite unchanged. Thus the glycerol treatment may be said to eliminate the undesirable results of the expanding lattice of montmorillonite. Other polyhydric alcohols, such as ethylene and trimethylene glycols, give rather similar effects with montmorillonite; but in all other cases tried so far, the basal spacing varies with the state of hydration.

(4) *Easy distinction from other clay minerals, including illite (hydrous mica)*. The 17·7 A. reflexion is very characteristic, and the second-order reflexion at 8·85 A. does not interfere with a line given by any other likely mineral. Moreover, tests with illite (from Grundy County, Illinois) show that the position of its basal reflexion is completely unaffected by the treatment. In view of the claims of Jackson *et al.*[3] that an expansion of the illite lattice may be caused by certain hydration procedures, this point is not without importance.

Part of the work mentioned above was done during the tenure of a grant from the Agricultural Research Council, to which I wish to express my thanks.

DOUGLAS M. C. MACEWAN.

Macaulay Institute for Soil Research,
Aberdeen.

Sept. 16.

[1] Nagelschmidt, G., *Z. Krist.*, **93**, 481 (1936).

[2] Nagelschmidt, G., "The Mineralogy of Soil Colloids" (Tech. Com. No. 42, Imperial Bureau of Soil Science, Harpenden), p. 15.

[3] See Aldrich, Hellman and Jackson, *Soil Sci.*, **57**, 215 (1944) where references are given to the previous papers of the series.

[4] Nagelschmidt, G., *J. Sci. Instr.*, **18**, 100 (1941).

## A Modification of the Method for Estimating the Anti-bacterial Activity of Fungi that are Difficult to Grow on Liquid Media

RECENTLY[1] we published a method which was specially designed to estimate the anti-bacterial activity of certain fungi, for example, the Basidiomycetes, which are difficult to grow on liquid media. Briefly, the method consisted in cutting a disk from a growing fungus colony and dropping it into a plate of warm agar which had been bulk-seeded with bacteria. In case of a positive result a zone of bacterial inhibition was produced round the disk. The method stated that "all disks are cut at approximately the same distance from the edge of the colony". An attempt to determine what distance from the edge of the colony would give the best result brought out certain objections to the method and led to the present modification.

The main difficulty was that the disks did not always produce a zone of inhibition of uniform width; in some cases the width on one side of the disk was twice that on the other side. Assuming the colony was allowed to grow to a diameter of 2½ in., the radius permitted disks of 11 mm. to be cut at different distances from the edge, and it was found that there was variation in the shape of the zone according to whether the disk was cut from near the edge or near the centre of the colony. The zone might be perfectly centric around the disk wherever the disk was cut out; but in most cases it was not. In general, there were two variants on the centric type. Fig. 1 *A* shows a disk (*d*) cut near the edge (*e*) and some distance from the centre (*c*) of the fungus colony.

When the disk was placed in the bacteria-seeded plate, the zone of inhibition might be of the type shown in Fig. 1 *B*, that is, having the widest part of the zone of inhibition at that part of the disk which had been towards the centre of the fungus colony, or it might be of type Fig. 1 *C*, where the widest part of the zone was at that side of the disk which had been farthest from the centre of the colony. The first

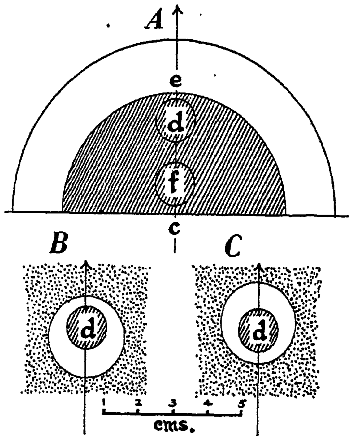



FIG. 1. FUNGUS MYCELIUM SHADED ; BACTERIAL COLONIES STIPPLED. EXPLANATION IN TEXT.

type indicated that it was the older region of the mycelium that was producing the greatest concentration of inhibitory substance, the second type indicated that it was the young mycelium near the growing edge that was responsible for the higher concentration. Apart from the interesting fact that in some fungi it is the older and in others the younger part of the mycelium that produces inhibitory substances, apart also from the difficulty of using the method as any more than a positive/negative test, the above variations might be so pronounced as completely to invalidate the results. When two disks were cut from certain fungus colonies, one (*d*) near the edge and the other (*f*) near the centre, the one gave a zone of inhibition, centric or eccentric, but the other gave no zone at all. Hence the position from which the mycelial disk was cut was of paramount importance. To obviate the necessity for cutting more than one disk, the following modification of the method was adopted, and has proved to be quite as simple and more informative than the original.

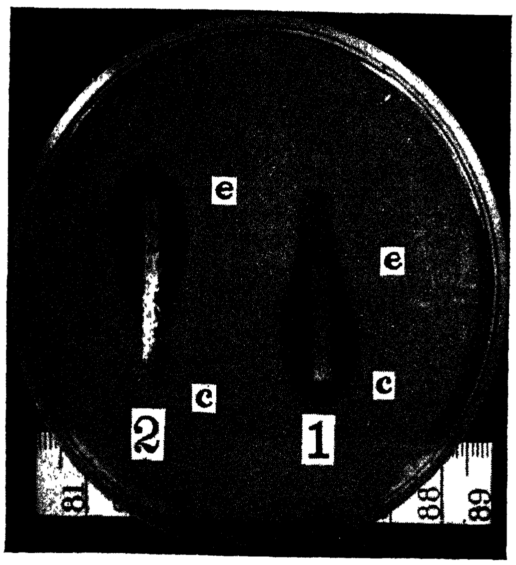



FIG. 2. SHOWING BOTH TYPES OF INHIBITION.

A strip of mycelium and agar 4 mm. wide is cut, by means of a safety razor blade apparatus, right across the centre of the plate containing the fungus colony. This strip is divided at the centre into two equivalent halves, one half is put into a plate of warm agar bulk-seeded with *Staphylococcus aureus* and the other half is put into a similar plate seeded with *Bacterium coli*. Comparable results against the two types of bacteria are thus possible, and comparisons between the effects produced by different fungi and between the effects produced by the same fungus on different media are also facilitated. The sort of result which is obtained is shown in Fig. 2, which is a photograph of two mycelial strips in a plate of *Staph. aureus*.

Strip No. 1 is cut from a growing colony of the basidiomycete fungus *Tricholoma nudum*, a fungus which typically produces the greatest concentration of inhibitory substances from the older region of the mycelium. Strip No. 2 is cut from another basidiomycete, *Clitocybe aurantiaca*, which produces inhibitory substances only from the younger region of the mycelium. The degree of inhibition is determined by measuring the greatest diameter of the zone of inhibition wherever that may be in relation to the mycelial strip. So far as we yet know, growing any given fungus on different media may alter the degree but does not alter the type of inhibition.

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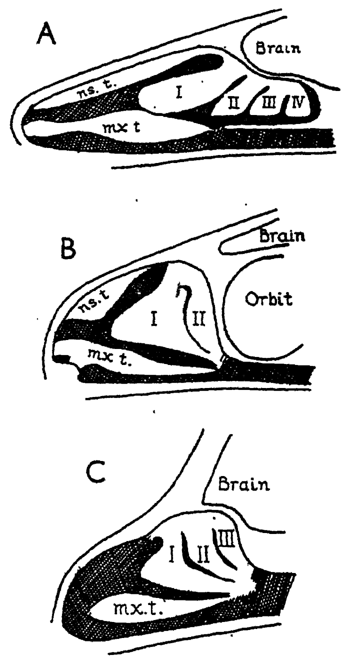
[1] Wilkins, W. H., and Harris, G. C. M., *Nature*, 153, 590 (1944).

## Meristic Variation and Reversibility of Evolution

PROJECTING into the nasal fossa of any generalized metatherian or eutherian mammal is a series of turbinals, namely, a naso-turbinal (Fig. *A*, *ns.t.*), a maxillo-turbinal (*mx.t.*) and four ethmo-turbinals (I–IV), and there can be little doubt that such an arrangement characterized the remote ancestors of the Primates. But in all primitive Primates (from which we exclude the Lemures), including such forms as *Tarsius* (Fig. *B*), *Hapale*, *Chrysothrix* (*Saimiri*), *Cebus* and *Lagothrix*, there are but two ethmo-turbinals (I, II), for in these forms the orbital cavities have so enlarged as to obliterate by their approximation the posterior part of the ancestral nasal fossa. In the baboon, gibbon (Fig. *C*), chimpanzee and gorilla, and in man, the nasal fossæ are again enlarged, partly at least as a result of the growth in width of the skull-base in support of an enlarged brain, and in all these forms three[1], and in man sometimes four[2] or even five[3], ethmo-turbinals may be developed. The phylogenetic trend in Primates seems, therefore, to have been towards a reduction of the turbinal series in early forms and a secondary expansion thereof in certain of their descendants.

Dollo's 'law of irreversibility', even in its modern phrasing: "Evolution is reversible in that structures or functions once gained may be lost, but irreversible in that structures or functions once lost can never be regained"[4]—does not apply here, for ethmo-turbinal III has been lost in primitive Primates and has




reappeared in certain recent forms. Arber[5], quite independently of Dollo, formulated from botanical evidence a 'law of loss', the "general rule that a structure or organ once lost in the course of phylogeny can never be regained; if the organism subsequently has occasion to replace it, it cannot be reproduced, but must be constructed afresh in some different mode", and later collected such data as had been submitted from time to time as evidence contrary to Dollo's law. Such evidence included the re-acquisition of a lost toe in a laboratory race of cavy, the re-development of lateral digits in some horses, the occasional presence of a fifth stamen in anomalous Iris specimens. Arber pointed out that these were all cases of meristic variation and that Dollo's law did not apply to them.

The present instance of the nasal turbinals is also meristic in nature, but is derived from normal anatomy and not from teratology: it is bound up with the fundamentals of Primate evolution.

The ambiguity of Dollo's law depends upon the interpretation of the words 'structure' or 'organ'. Presumably if the entire Primate ethmo-turbinal series had been phylogenetically lost, no single turbinal could ever have been regained: but so long as even one member of the series persisted in primitive Primate forms, the redevelopment in descendant recent forms of the full turbinal complement remained a possibility. It seems advisable, therefore, to add to the law a rider to the effect that, in the case of structures constituting a series, the law applies to the series as a whole, and not to the individual members thereof.

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[1] Cave, A. J. E., and Haines, R. W., *J. Anat.*, **74**, 493 (1940).
[2] Schaeffer, J. P., *J. Morph.*, **21**, 613 (1910).
[3] Paulli, S., *Morph. Jb.*, **28**, 483 (1900).
[4] Needham, J., *Biol. Rev.*, **13**, 225 (1938).
[5] Arber, A., *Amer. J. Sci.*, **48**, 27 (1919).

## Failure of *Iso*-Immunization to *M* and *N* Agglutinogens in Man

Since the *A*, *B* and *Rh* agglutinogens so frequently invoke an immune response, either between mother and baby or as the result of incompatible blood transfusions, speculation has arisen to explain why differences in *M* and *N* type of donor and recipient, or of baby and mother, do not have the same effect.

The *M* and *N* agglutinogens are good antigens in animals; but the work of Kosjakov and Tribulev[1] may provide an explanation for the absence of any regular response to the *M* and *N* antigens in man. In an attempt to demonstrate the presence of these substances in the body tissues by means of the inhibition of the corresponding anti-serum, Kosjakov and Tribulev found that non-specific inhibition was so marked that the result was always such as to suggest that both *M* and *N* were present in the tissue under investigation. They discovered, however, that if, for example, the tissue thought to contain the *M*-group substance was first saturated with an anti-*N* serum it was then capable of specifically inhibiting an anti-*M* serum. Similarly, before specific absorption by *N*-group substance could be demonstrated it had first to be saturated with anti-*M* agglutinins.

This suggests that anti-*M* or anti-*N* agglutinins will only rarely appear in the serum of a mother who is carrying a baby of dissimilar *M* or *N* type, or following a blood transfusion, because of the marked non-specific absorptive capacity of human tissues for these *iso*-agglutinins.

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[1] *J. Immunol.*, **37**, 283 (1939).

## Lichen Substances Containing Nitrogen

It is a matter of interest that, notwithstanding the very large number of substances that have been isolated from lichens, there is only one recorded example of a material containing nitrogen, namely, picroroccellin, isolated by Stenhouse and Groves in 1877 from a variety of *Roccella fuciformis*, and to which they attribute the formula $C_{27}H_{29}O_6N_3$.

From the lichen *Lecanora epanora* we have isolated two yellow nitrogen-containing constituents, rhizocarpic acid and epanorin. Rhizocarpic acid, which is found in many lichens, has hitherto been regarded as consisting solely of carbon, hydrogen and oxygen; we find that it has the formula $C_{28}H_{23}O_6N$ and that, on hydrolysis with strong alkali, it breaks down into methyl alcohol, oxalic acid, phenyl acetic acid and a colourless acid of formula $C_{17}H_{17}O_3N$. Our analytical data for epanorin which, like rhizocarpic acid, contains one methoxyl group, accord best with the formula $C_{21}H_{21}O_5N$; on alkaline hydrolysis it gives rise to methyl alcohol, oxalic acid, phenyl acetic acid and a colourless acid of formula $C_{14}H_{19}O_3N$. The products of hydrolysis indicate $C_{25}H_{25}O_6N$ as an alternative formula for epanorin.

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## Alleged Role of Fructofuranose in the Synthesis of Levan

THE view was long widely entertained that cells synthesize macromolecules of polysaccharides and proteins by a reversion of the process of hydrolysis. It has been suggested accordingly that the synthesis of the polyfructoside levan specifically from aldosido< >fructofuranosides (sucrose, raffinose) involves two distinct steps: first, hydrolysis of the substrate; secondly, polymerization of fructofuranose by a condensation involving removal of water[1]. Bacteria which form levan from sucrose do so also from raffinose[2]. This polymerative type of sucrose degradation is concurrent with an ordinary hydrolytic inversion[3,4]. The same bacteria ferment levan[3]. Investigators might be tempted by these correlations to consider the enzyme system, levansucrase, to be but a mixture of invertase and polyfructosidase. It is shown below, however, that this view cannot be valid.

(*a*) Owen[5] added yeast invertase solution to cultures of bacteria growing in a sucrose medium. The addition did not augment but inhibited formation of levan by the cells. The findings suggested that invertase is not an essential component of the levan-forming enzyme, but since it referred to living and proliferating cells a final conclusion in this respect could not be drawn[6]. The recent preparation of cell-free levansucrase from *Aerobacter*[3] has made it possible to carry out Owen's experiment in conditions free from the criticisms to which his earlier attempt is open. It has been found that addition to this levansucrase of yeast invertase in amount sufficient to double the rate of sucrose decomposition does not affect levan production in solutions containing a high initial concentration of sucrose (more than 5 per cent). In solutions containing levan-formation-limiting concentrations of sucrose (less than 2 per cent), addition of yeast invertase to the levansucrase caused inhibition, rather than augmentation, of levan production.

On the view that fructofuranose is the substrate actually polymerized by levansucrase, it is still possible to explain the failure of invertase to accelerate levan production from a non-limiting concentration of sucrose by assuming that in this process hydrolysis, though essential, is not a rate-limiting step. This complicating possibility is eliminated where the rate of levan production is known to be dependent on the sucrose concentration. It is similarly eliminated in reactions carried out on raffinose. Levan is produced much more slowly from raffinose than from an equivalent concentration of sucrose[7]. If the reaction proceeds via fructofuranose, the rate-limiting step on raffinose can only be hydrolysis, subsequent steps by the terms of the theory being identical for both sucrose and raffinose. Yet addition to levansucrase of enough yeast invertase to render the rate of raffinose hydrolysis by the enzyme mixture equal to the rate of conversion of sucrose by levansucrase alone failed to augment, and in the long run inhibited, the rate of production of levan from raffinose. The conclusion is therefore confirmed that invertase is irrelevant to levan production from sucrose and raffinose by levansucrase.

(*b*) There is further direct evidence that fructofuranose is not a substrate which can be polymerized by levansucrase. Isbell and Pigman[8] have concluded on the basis of measurements of optical rotation that fructose in aqueous solution is an equilibrium mixture of fructofuranoses and fructopyranoses. The recent demonstration that glucose-1-phosphate (Cori ester) and fructose form a dynamic equilibrium with sucrose and phosphoric acid in the presence of a specific enzyme[9] corroborates this view. Addition of fructose to sucrose does not inhibit levan production from the latter, yet fructose itself, although it presumably contains ready fructofuranose, is not converted into levan by levansucrase[7]. Similarly, levansucrase fails to form levan from reaction mixtures in which fructofuranose is sustainedly liberated in *statu nascendi*, for example, in reaction mixtures of methyl gamma fructoside + yeast invertase, and of inulin inulase.

(*c*) Extracts of an *Aerobacter*, although they produce levan from sucrose and hydrolyse the latter as well, do not hydrolyse levan. Thus they contain levansucrase and invertase but no polyfructosidase (levanase)[7]. On the other hand, takadiastase and an extract of a *Torula* yeast have been found to hydrolyse levan and inulin as well as sucrose, yet produced no levan from the latter. Thus they contain invertase as well as polyfructosidase yet are without levansucrase.

The conclusion is therefore indicated that fructofuranose is not an intermediary of levan synthesis from aldosido< >-fructofuranosides. The view of macromolecular biosynthesis as a reversion of hydrolase action apparently fails to describe levan production, even as it fails to depict the biological production of glycogen and starch.

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[1] Smith, G., *Proc. Linn. Soc., N.S. Wales*, **26**, 593 (1901).
[2] Hibbert, *et al.*, *Can. J. Res.*, **4**, 221, 596 (1931).
[3] Hestrin *et al.*, *Biochem. J.*, **37**, 450 (1943); *Nature*, **149**, 527 (1942).
[4] Hestrin and Avineri-Shapiro, *Nature*, **152**, 49 (1943).
[5] Owen, *J. Bact.*, **8**, 420 (1923).
[6] Norman, "The Biochemistry of Cellulose, Lignin, Polyuronides, etc." (Oxford, 1937).
[7] Hestrin and Avineri-Shapiro, *Biochem. J.*, **38**, 2 (1944).
[8] Isbell and Pigman, *J. Res.*, *U.S. Nat. Bur. Stand.*, **20**, 773 (1938).
[9] Doudoroff, *J. Biol. Chem.*, **151**, 358 (1943).

## A Blind Woodlouse

WHEN examining some specimens of *Armadillidium vulgare* (Latr.), kindly sent to me by Dr. H. W. Howard of Cambridge from the University Farm, I noticed that a female specimen of the variety "Black type B" of Howard[1] was entirely void of eyes or any trace of them. In this example there is no trace of any visual elements or even pigment. The chitin on the cephalon, where the eyes should be, is very slightly convex, shelving down laterally and inwardly.

During the past thirty years, I have examined many thousands of specimens referable to this species, but I have never met with one in which the eyes were absent, or in any other species of terrestrial isopod excepting in truly cavernicolous ones.

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Oct. 2.

[1] *J. Genetics*, **40**, 83, pl. iv, fig. B (1940).

# NATIONAL FLOUR AND BREAD

From the Scientific Adviser's Division, Ministry of Food

THIS report, the fifth to be issued[1], covers the samples of flour examined in the period January 1 to September 2, 1944, and loaves from January 1 to October 2.

## Quality of Flour

423 samples were analysed with the following results:

| Fibre | | Vitamin $B_1$ | |
|---|---|---|---|
| Value per cent | Per cent of samples | I.U./gram | Per cent of samples |
| 0·4 or less | 10·9 | 1·1 or more | 3·3 |
| 0·5 ,, | 52·7 | 1·05 ,, | 12·3 |
| 0·55 ,, | 70·7 | 1·0 ,, | 35·7 |
| 0·6 ,, | 80·7 | 0·95 ,, | 62·1 |
| 0·7 ,, | 92·7 | 0·9 ,, | 82·0 |
| 0·8 ,, | 98·1 | 0·8 ,, | 97·1 |

The fibre figures are corrected for any added white flour.

*Riboflavin, Nicotinic Acid, Iron, Protein, Ash and Maltose.* For these determinations the samples received in each of the months January–June inclusive were compounded.

| Month | No. of samples | Riboflavin (μgm./gm.) | Nicotinic acid (μgm./gm.) | Iron (mgm./100 gm.) | Protein per cent | Ash* (per cent) | Fibre (per cent) | Maltose (per cent) |
|---|---|---|---|---|---|---|---|---|
| January | 72 | 1·2 | 17 | 2·15 | 10·9 | 1·0 | 0·50 | 2·35 |
| February | 64 | 1·2 | 17 | 2·12 | 10·8 | 0·97 | 0·50 | 2·3 |
| March | 60 | 1·3 | 17 | 1·94 | 10·0 | 0·96 | 0·50 | 2·3 |
| April | 60 | 1·4 | 17 | 1·98 | 10·8 | 0·94 | 0·50 | 2·1 |
| May | 40 | 1·4 | 16 | 2·01 | 10·9 | 0·96 | 0·50 | 2·05 |
| June | 50 | 1·3 | 17 | 2·20 | 10·8 | 1·04 | 0·50 | 2·3 |

* All the flours were fortified with calcium carbonate at the rate of 7 oz. per sack of 280 lb. The ash due to this addition would average 0·12 per cent. No skim milk powder was added after March 1944.

Average figures for National flour in the period were therefore:

| | | | |
|---|---|---|---|
| $B_1$ | 0·95–1·0 I.U./gm. | Protein | 10·7 per cent |
| Riboflavin | 1·3 μgm./gm. | Fibre | 0·50 ,, |
| Nicotinic acid | 17 ,, | Ash | 0·98 ,, |
| Iron | 2·07 mgm./100 gm. | Maltose | 2·2 ,, |

*Granularity.* In 1944 (up to October 4) 549 samples of flour have been examined with the following results:

| Samples | % over 5 silk | % over 8 silk |
|---|---|---|
| 1–100 | 1·2 | 4·7 |
| 101–200 | 1·1 | 4·4 |
| 201–300 | 0·8 | 4·1 |
| 301–400 | 0·7 | 3·7 |
| 401–549 | 1·0 | 4·3 |

Aperture No. 5 silk = 0·270 mm.
,, No. 8 ,, = 0·190 ,,

*Baking Quality.* All the flours were test-baked under optimum conditions of water absorption and fermentation, and the resulting bread graded according to quality (commercial standards).

257 samples of flour gave good bread = 60·7 per cent of samples.
81 ,, ,, ,, ,, fair-good ,, = 19·2 ,, ,, ,, ,,
67 ,, ,, ,, ,, fair ,, = 15·8 ,, ,, ,, ,,
18 ,, ,, ,, ,, poor ,, = 4·2 ,, ,, ,, ,,

## Quality of Bread

3,358 loaves from different parts of Great Britain were graded for quality (commercial standards).

Good = 461 loaves = 13·7 per cent
Fair-Good = 1393 ,, = 41·5 ,, ,,
Fair = 1027 ,, = 30·6 ,, ,,
Poor = 477 ,, = 14·2 ,, ,,

It will be observed that the first two groups totalled 55 per cent against 80 per cent for the flours baked under ideal conditions in the laboratory.

This work was carried out at the Cereals Research Station, Ministry of Food, St. Albans.

[1] See *Nature*, **149**, 460 (1942); **150**, 538 (1942); **151**, 629 (1943); **153**, 154 (1944).

# PHYSICO-CHEMICAL ANALYSIS IN U.S.S.R.

IN 1904 Prof. N. S. Kurnakov (1860–1941) invented a new form of recording pyrometer which was a great improvement on that of Roberts-Austen. In 1910 Prof. A. A. Baikov still further improved this pyrometer by a modification which allowed the recording of the differential curve to be superimposed on the ordinary cooling or heating curve. This apparatus provided a very delicate method for the thermal analysis of alloys and minerals, called by Kurnakov in 1913 'physico-chemical analysis'[1]. Through the initiative and enthusiasm of Kurnakov, a very flourishing school of research was established, and in 1918 a special Institute of Physico-Chemical Analysis was founded at the Academy of Sciences.

The scope and purpose of this Institute was defined by Kurnakov in the following words: "The Institute of Physico-Chemical Analysis has for its aim the study of the relations between the composition and the measurable properties of systems in equilibrium of two or more components. Being in reality one of the subdivisions of general chemistry, physico-chemical analysis can be of a wide application in the border regions of theoretical and applied science—mineralogy, petrology, geology, metallurgy and applied and structural mechanics. It is a very significant fact that a systematic investigation of the diagram 'composition-properties', the essential method of this new chemical discipline, allows us to draw conclusions about the nature of solid, liquid or gaseous substances, without subjecting them to the usual chemical operations of separation. Because of that, a whole range of substances—alloys, glasses, slags, rocks, liquid and solid solutions, colloidal systems and various ores—are now included within the range of a systematic chemical investigation"[2].

In 1940 the friends of N. S. Kurnakov decided to celebrate his eightieth anniversary by publishing a special volume of collected papers. The sad event of Kurnakov's death on March 19, 1941[3], made it necessary to recast the proposed volume and a memorial volume was published instead[4]. This volume contains twenty-nine articles written by Kurnakov's close associates and friends. The first eight articles deal with the biography, bibliography and the scientific work of Kurnakov. Every application of the physico-chemical analysis—alloys, organic

and complex compounds, minerals and ores—is discussed in a special article by a leading authority on this subject. The remaining articles deal with original research and they include the following topics: thermographic methods, viscosity of liquid systems, properties of various chemical systems and alloys, potash salts, etc. The volume is well printed and provided with the portrait of N. S. Kurnakov and numerous plates of photomicrographs and diagrams. Unfortunately there are no English summaries.

It is rather difficult to give an adequate account of the achievements of Kurnakov's school of research, but specialists in given branches of chemistry and other sciences are probably acquainted with the abstracts of Russian papers and with the papers published in the *Z. anorg. Chem.* and *J. Inst. Metals.* The whole range of these publications can be roughly assigned to three sections: (1) metals, (2) minerals and ores, and (3) general chemistry. The works dealing with metals are chiefly concerned with the thermal study of alloys from the point of view of the phase rule, and a very detailed correlation of the composition with viscosity, hardness, electro-conductivity, etc., is usually made. The works dealing with minerals and ores cover a wider ground. First in order of importance comes the study of the equilibrium of salt solutions, a study which not only made a valuable contribution to theoretical science but also greatly helped in the development of Russian salt deposits and the salt industry. The application of physico-chemical analysis to other minerals and ores has embraced practically all classes of minerals: silicates, carbonates, oxides, borates, native elements, etc. Probably the most outstanding achievement was the study of the minerals of the platinum group, clay minerals and bauxitic minerals, a work which had a most important practical application in the U.S.S.R. Of the problems concerned with the general chemistry one may mention the study of organic compounds, compounds with complex radicals, the general study of equilibrium systems and the topology of the equilibrium diagram.

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[1] Kurnakov, N. S., "An Introduction to Physico-chemical Analysis". Publication of the Acad. Sci. U.S.S.R., 1st ed., pp. 87 (1925); 4th ed., pp. 562 (1940) (in Russian).

[2] Kurnakov, N. S., *Ann. Inst. Phys.-Chem. Anal.*, **2**, 473 (1924) (in Russian).

[3] Briscoe, H. V. A., *Nature*, **148**, 310 (1941).

[4] *Annales du Secteur d'Analyse Physico-Chimique. Inst. de Chimie Générale, Acad. Sci. URSS.*, **14** (1941) (in Russian).

# SOLAR RADIATION OBSERVATIONS AND VOLCANIC DUST

It was observed by Dr. C. G. Abbot that dust from the Alaskan volcano Katmai in June 1912 affected the transparency of the atmosphere in the northern hemisphere, but failed to influence the pyrheliometric observations at Arequipa, Peru. This led George G. Gallagher of Glendale, California, to inquire whether or not dust from southern hemisphere volcanoes influenced the atmosphere in the northern hemisphere. This matter has just been investigated by L. B. Aldrich from the records of the Smithsonian solar-radiation stations for the Chilean Andes eruptions of April 1932*.

* "Smithsonian Pyrheliometry and the Andean Volcanic Eruptions of April 1932", by L. B. Aldrich. *Smithsonian Misc. Coll.*, **104**, No. 6, July 3, 1944.

The Andean eruptions of 1932 started on April 10, involving some seven volcanoes extending two hundred miles along the Chile–Argentine border from Tupungato (altitude 2 ,000 ft., lat. 33·5° S.) southward to Quizapu (altitude about 10,000 ft.). Loud explosions were heard 100 miles on either side of the volcanoes. The explosions continued for three days. Surrounding towns were in semi-darkness owing to the steady fall of dust and ashes. In Montevideo, 850 miles away, the steady fall of dust continued for many hours. The late Dr. C. Davison estimated the fall of dust over the area to be more than five cubic miles. Capt. R. Wooten, United States Air Attaché at Santiago, who flew across Quizapu at an altitude of 14,000 ft., estimated that at the time of greatest activity the smoke column rose to a height of 30,000 ft. Evidences of unusual dust in the atmosphere were noted at Wellington, New Zealand, on May 7, reaching a maximum about May 26. Unusual skies were also reported during May from various places in South Africa.

During this time the Smithsonian Institution was operating solar-radiation stations at Montezuma (latitude 22° 40′ S., longitude 68° 56′ W.) and at Table Mountain, California (latitude 34° 22′ N., longitude 117° 41′ W.). At both these stations, on all days when the sky around the sun was clear, observations were made with the silver-disk pyrheliometer, measuring the total solar radiation received upon a surface normal to the radiation. Simultaneously, readings were taken with a pyranometer, measuring the brightness of the sky in a circular zone about 10° wide, concentric with the sun. These pyranometer readings are an index of the quantity of dust in the atmosphere. Values of pyrheliometry and pyranometry at air mass 2·0 (solar altitude 30°) were selected from the observations and used uncorrected to mean solar distance. These were grouped by months and so chosen that the average amount of water vapour in the air above the station was the same in each year for a given month. The amount of water vapour in the air may be represented by the spectrobolometrically determined precipitable water value. The year 1930 was taken as a standard for comparison. The following tables, obtained by L. B. Aldrich, indicate the results of the investigation.

PERCENTAGE DEVIATIONS OF PYRHELIOMETRY AND SOLAR CONSTANTS FROM CORRESPONDING MONTH OF 1930.

| | Pyrheliometry | | |
|---|---|---|---|
| | Montezuma | Table Mountain | Solar Constant |
| Month | per cent | per cent | per cent |
| May 1932 | −3·7 | +0·8 | −0·4 |
| June ,, | −3·4 | −0·5 | −0·1 |
| July ,, | −2·6 | −0·1 | −0·1 |
| Nov. ,, | −2·1 | 0·0 | −0·2 |
| May 1933 | −0·1 | −0·4 | −0·4 |

PERCENTAGE CHANGE OF SKY BRIGHTNESS AROUND THE SUN FROM CORRESPONDING MONTH OF THE YEAR 1930.

| Month | Montezuma | Table Mountain |
|---|---|---|
| | per cent | per cent |
| May 1932 | +157 | −23 |
| June ,, | +114 | − 3 |
| July ,, | + 87 | − 5 |
| Nov. ,, | + 44 | + 1 |
| May 1933 | − 19 | + 8 |

No effect of the Andean eruptions is discovered in the Table Mountain, California observations. A definite effect occurs in the Montezuma pyrheliometer values, with a maximum of 3·7 per cent depletion in May 1932, and an average of 3·0 per cent for the months May, June, July, November. This agrees with Mr. Gallagher's estimate.

From the Montezuma records, the following unusual sky observation reports are taken (1932: C. P. Butler, director).

April 13. Horizon to south very hazy with yellowish-looking dust. Nothing further is noted until—

April 22. Good sky. Very hazy over mountains to east.

April 23. Very heavy layer of yellowish haze over mountains to east, extending up to about 10°.

April 24. Very poor sky. Streaks from horizon to zenith, with whitish glare about sun.

April 25 and 26. Same notes as on April 24.

April 27 through 30. Dust in atmosphere almost totally obscures sun.

On April 30 the pyranometer value at air mass 2·0 was 0·131 calorie—ten times the normal value.

It should be noted that Montezuma is more than eight hundred miles north of the erupting volcanoes.

## CARE OF THE WOUNDED

THOSE who had the experience of being transported, after the War of 1914–18, from, say, the less civilized Iraq of those days to a bed in one of the temporary military hospitals in England considered that they were being handled by an organization which it would be difficult to improve. But we realize, when we read the three articles contributed by a Special Correspondent to the *Lancet* (253, August 19, 1944; 278, August 26, 1944; 383, September 16, 1944), how much more is now being done for the wounded and the sick. These three articles on the wounded from Normandy must be read; they cannot be summarized. They explain why the casualty-rate among the wounded has been low. The doctor and the medical organization go right forward into the battle; paratroops and tanks have their field ambulances; the soldier knows much more about first-aid and about how to keep himself fit; surgical treatment is given early; blood transfusions are given much earlier; penicillin is available everywhere; and air transport, described in the second article, has been well organized. When they get to Britain, the wounded pass into the hands of the home hospital services and their network of ancillary organizations, which extend right back to the humblest civilian who goes along, when he is asked to do so, to give a pint of blood. The destinies of that blood have been described in the Press and pictured on the cinema screen. They are symbolic of the whole service. It is to be hoped that, after the War, this organization will be applied to national life in peace as well as in war, and that the soldier will bring back into civil life the knowledge of how to keep fighting fit which the R.A.M.C. has taught him so well that "nothing like it has ever been done either in military or civil life".

For those who are interested in this subject, the article entitled "Military Surgery in Geographical Perspective", by Ian Aird, late Lieut.-Colonel R.A.M.C. (*Edinburgh Med. J.*, 51, 166; April 1944) will be of great interest. The author deals with surgical strategy and tactics in Libya and discusses the influence of the physiography, climate, water supply, soil bacteriology, dust and sand storms, populations and communications of Libya on the planning of surgery for the campaign there. Little help was obtained from the history of previous North African campaigns. The rapid movement of the war there demanded mobile, self-contained units, and the caravan- and tent-operating theatres used are shown in photographs. The rest of the article describes the surgical technique employed, the water shortage and evacuation of the wounded by air. It may be compared with many other articles on the treatment of war wounds which have appeared in the medical Press.

Almost as frequent have been articles on the transport of the wounded or of those injured in air raids. Among these there have been numerous descriptions of stretchers designed for rapid transport of injured people and adapted for use for artificial respiration as well. D. G. Duff (*Lancet*, 798, June 17, 1944; see also the *Lancet*, 739, June 3, 1944) describes one of these stretchers. Dr. Duff's stretcher is the result of experiments made over six years, experience of climbing accidents being included. Photographs of it illustrate its use. It is comparable in weight and ease of production to the standard army stretcher, and can be used as a breech buoy and for Eve's rocking method of artificial respiration. Runners beneath it enable it to "be its own vehicle" on any slope and on rock, grass, scree, heather, ice and snow; or it can be used for lowering a patient from a window. A wheeled undercarriage is available and a collapsible form of it can be got into a package 4 ft. 6 in. × 10 in. × 4 in.

## BIOLOGICAL STUDIES IN BRAZIL

BRAZILIAN biologists and medical men have made, and are making, valuable contributions to knowledge. The wide field which they cover is indicated, not only by their medical journals, but also by the policy of some of their biological periodicals, which publish articles on subjects which, in other countries, would be printed in medical literature. Thus the *Revista Brazileira de Biologia* (3, No. 4; 1943) contains papers on immunology, such as those on protection tests with Felix's antityphoid serum, on oxidation and reduction of complement and on the antibodies to the virus of equine encephalomyelitis; and others on cryo-epilepsy, on Henry's melano-flocculation reaction and on Wolff's buffer-precipitation test in malaria, Chagas's disease and schistosomiasis. Another paper discusses the action of acetylcholine and of adrenalin on the coronary arteries of the Brazilian macacus monkey, *Allouata fuscus*. The rest of this issue deals with more specifically biological subjects. Thus there are articles on two Lepidoptera, *Automolis* and *Rhipha*; and on the unity or duality of the males of the hymenopterous parasite, *Telenomus fariai*, in which the author concludes that the two classes of males are morphologically identical, produce the same progeny from the female and always have ten chromosomes, while the female has twenty. Their difference in size depends on the amount of food that is available. Other articles deal with a new trematode species, *Catadiscus mirandai*, from the large intestine of *Hemipipa carvalhoi*, with some spiders of Chile, with two new species of *Stenolemus* (Reduviidæ, Hemiptera) and with the hyoid and laryngeal apparatus of some Microchiroptera. Botanists will be interested in the article on the nomenclature of *Capsicodendron Dinisii* (syn. *C. pimentiera*, Canellaceæ). The social importance of scientific investigation is discussed by Dr. Oswaldo Cruz, of the famous Institute which bears his name.

Another Brazilian biological journal, *Zoologia* (No. 7. 1943. Boletim 32, Universidade de São Paulo, Brasil), although chiefly biological, contains a paper by Paulo Sawaya on the occurrence of acetylcholine in the cardiac tissues of the marine crab, *Callinectes danæ*, which "is perhaps the commonest swimming crab in Brazil". A large quantity of acetylcholine was found in the cardiac tissue. The technique of attempts to perfuse the heart is described and the effects on the heart of acetylcholine, eserine, atropine, nicotine and adrenalin are described. Extracts of the cardiac tissue of *Callinectes danæ* contained substances which acted like acetylcholine on the hearts of the amphibians *Bufo marinus* and *Siphonops annulatus*. The experiments indicated that *Siphonops annulatus* can be used for testing the action of acetylcholine. Five plates record the kymograph tracings (cardiograms) obtained with the hearts of these three species.

The greater part of this issue is, however, occupied by a paper of 246 pages on the Naididæ of Brazil, by Ernesto Marcus, with a summary in English of ten pages, a bibliography of seven pages and 33 plates. The paper discusses the structure, bionomics and taxonomy of 24 species, all found near the city of São Paulo and in the State of São Paulo. They belong to the genera, *Chætogaster*, *Nais*, *Dero*, *Aulophorus*, *Pristina* and *Naidium*. Some problems of variability, morphogenesis, regeneration and histology are considered.

In the same volume, Michel P. Sawaya discusses the intrazoœcial rings of the Crisiid Bryozoa, and Domingos Valente describes his work on the effect of numbers of individuals on the oxygen consumption of the crab *Trichodactylus petropolitanus*, which normally lives in darkness under stones and water plants in rivers. The author concludes that the isolated animal uses oxygen at a greater rate than do groups of four crabs; and two crabs used more than four. This group effect is not eliminated by darkness. The effect of visual stimuli on oxygen consumption was studied in crabs placed in relation to their own mirror images in aquaria mirrored on one vertical side. The oxygen consumption of isolated crabs thus placed in contact with their own mirror images was decreased. Mirror image and group effects are thus both positive, but the former were not very marked.

G. LAPAGE.

## SYSTEMATICS OF THE POTATO

A THOROUGH understanding of potato taxonomy is a necessary pre-requisite of a large-scale programme of breeding for new types. With this in view the British Empire Potato Collecting Expedition sent out by the Imperial Agricultural Bureaux during 1938–39 made extensive collections in Mexico and South America. The systematic results are now described by Dr. J. G. Hawkes (Imperial Bureau of Plant Breeding and Genetics, Cambridge, pp. 142, June 1944, 7*s.* 6*d.*), who has classified all the material obtained on a basis of morphological, geographical and cytological criteria. Five new cultivated and thirty-one new wild species are described in addition to very many new varieties and forms; but although some twenty cultivated and one hundred and fifty wild species of potato are now known, it is concluded that, at least so far as the wild species are concerned, the wealth of variation still lies practically untouched, and probably three or four times as many wild species await discovery in the less accessible regions.

The cytological investigation of the collections shows that it is only in Mexico that the whole polyploid series occurs. Here only six diploid species are known, whereas tetraploid, pentaploid and hexaploid types are common. In South America diploid wild species are the rule, and there are no pentaploid or hexaploid wild species and only one pentaploid cultivated species. Among cultivated species in every country tetraploid clones occur much more frequently than diploids, triploids and pentaploids.

As regards the origin and evolution of cultivated potatoes, reasons are advanced for supposing that moderately high-yielding wild potatoes were first taken into cultivation in the Lake Titicaca – Cuzco region of north Bolivia and south Peru. Light is thrown upon the problem as to which types of potato were first cultivated by an analysis of the different kinds of weed and semi-cultivated species. This leads to the conclusion that the tetraploid weed species may be either types that had once been cultivated and have now been replaced by higher-yielding varieties of *S. andigenum*, or amphidiploids which were never cultivated to any great extent. The diploid species, on the other hand, are probably the wild species most closely related to our cultivated diploids from which the tetraploids arose before or after their being taken into cultivation. The two tetraploids *S. andigenum* and *S. tuberosum* (*s.str.*) are considered to have had a common origin in the south Peru – north Bolivia region and not to have been derived from distinct wild species, while the evidence as to the origin of the European potato is thought to favour an introduction from the Andes, and most probably Columbia, rather than Chile as has been supposed.

## STRUCTURE OF THE WALLS OF PHLOEM FIBRES

R. D. PRESTON (*Chronica Botanica*, 7, 414; 1943) points out that there is now considerable scope for the botanist, and especially the biophysicist, to make his contribution to the knowledge of the fine structure of the cellulose walls of plant cells.

Owing to their commercial value, the fibres of the phloem (sclerenchyma) have so far been chiefly studied; in these the X-ray diagram indicates the presence of cellulose chains in the longitudinal direction only, while observations on swollen walls by optical methods have led to the view that at least two layers are present and that they differ in direction of the cellulose chains. Crossed cellulose chains definitely occur in the walls of certain algæ. The X-ray diagrams of hemp and jute fibres reveal the presence of only one direction of cellulose chains which runs parallel with the major extinction plane and remains unaltered during thickening processes of the fibre walls.

However, by optical examination of swollen walls, there is indication of heterogeneity in cross-section which does not appear to be accounted for in entirety by the differential distribution of lignin and pectin. The latter causes also differential swelling of the wall in different regions and leads to the production of striations of various kinds; also the swollen material is easily broken into separate fibrils with associated change in direction of cellulose chains, which appears to have misled at least one worker. Swelling under

certain conditions produces a 'ballooning' of the outer layer of the wall in hemp, but not in jute, and this fact, taken in conjunction with associated optical phenomena, suggest that the outer layer in hemp and the inner in jute differ appreciably from the rest of the wall.

It seems clear that in such walls the aggregates of the cellulose complex must differ in their association with one another in the different layers. Comparisons with long collenchyma cells suggest that the optical heterogeneity may be due to a variation in *angular dispersion* of the cellulose chains from layer to layer; this argument is less convincing for hemp and jute fibres, but not precluded by the X-ray diagram. There is therefore still doubt as to whether any chains exist in the secondary walls of these phloem fibres other than those which run in the longitudinal direction.

# FORTHCOMING EVENTS

### Saturday, November 4

Royal Aeronautical Society (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 10.30 a.m.—Discussion on Civil Aviation. General Critchley: "The Selection and Training of Personnel for Civil Aviation"; Major Thornton: "The Economics of Air Transport"; Mr. Roy Chadwick: "Civil Aircraft Design"; Mr. E. W. Hives: "Civil Aero-Engine Design"; Mr. W. P. Hildred: "Route Facilities (Radio, Aerodromes, Meteorology, etc.)".

Geologists' Association (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. L. Hawkes: "On Jet Coal in the Chalk of Kent".

### Monday, November 6

Farmers' Club (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Mr. J. L. Davies: "The Policy of Expansion of our Dairy Farming".

Society of Chemical Industry (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. A. Batley: "Use of Sensitized Metal in Engineering Design".

Royal Geographical Society (at Kensington Gore, South Kensington, London, S.W.7), at 5 p.m.—Lord Rennell of Rodd: "Italian East Africa in 1941".

### Tuesday, November 7

Royal Institution (at 21 Albemarle Street, Piccadilly, London, W.1), at 5.15 p.m.—Mrs. Jacquetta Hawkes: "Prehistoric Britain", (i) "The Early Colonizations".

Institution of Civil Engineers (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. F. E. Wentworth-Sheilds: Presidential Address.

Sheffield Metallurgical Association (joint meeting with the Sheffield and District Branch of the Institute of Welding) (at the Royal Victoria Station Hotel, Sheffield), at 6.30 p.m.—Mr. H. F. Tremlett: "Arc Welding Problems—Some Notes on Metallurgical Solutions".

Institution of Electrical Engineers (London Students' Section) (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. C. C. Barnes: "Notes on the Design and Manufacture of Impregnated Paper Insulated Power Cables".

Quekett Microscopical Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Exhibits.

### Wednesday, November 8

Institute of Fuel (North-Western Section) (at the Engineers' Club, Manchester), at 2.30 p.m.—Brains Trust on "The Efficient Utilisation of Industrial Waste and Town's Refuse".

Society of Chemical Industry (Food Group) (joint meeting with the Microbiological and Nutrition Panels) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. B. C. J. G. Knight: "Some Wider Aspects of Nutritional Studies with Micro-Organisms".

Chemical Society (joint meeting with the Manchester University Chemical Society and the Royal Institute of Chemistry) (in the Chemistry Lecture Theatre, The University, Manchester), at 5 p.m.—Prof. I. M. Heilbron, F.R.S.: "Chemistry in relation to National Prosperity".

Institution of Electrical Engineers (Transmission Section) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. D. B. Irving: "Cable Terminations".

### Thursday, November 9

Royal Institution (at 21 Albemarle Street, Piccadilly, London, W.1), at 2.30 p.m.—Sir James Jeans, O.M., F.R.S.: "Old and New Descriptions of the Astronomical Universe", (ii) "Stars".

Physical Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. S. K. Mitra: "The Night Sky".

Institution of Electrical Engineers (Installations Section) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. F. C. Fuke: "Electrical Accessories for Domestic Purposes—Some Notes on their Design and Installation".

Society of Chemical Industry (Edinburgh and East of Scotland Section) (in the Anatomy Lecture Theatre, The University, Teviot Place, Edinburgh), at 5.30 p.m.—Prof. Sir Alexander Fleming, F.R.S.: "Antiseptics" (Lister Memorial Lecture).

Pharmaceutical Society (at 17 Bloomsbury Square, London, W.C.1), at 7 p.m.—Mr. A. L. Bacharach: "Properties and Uses of Penicillin in relation to Pharmacy".

### Friday, November 10

Association of Applied Biologists (in the Metallurgical Lecture Theatre of the Imperial College of Science and Technology, South Kensington, London, S.W.7), at 2 p.m.—Discussion on "Nomenclature Problems of the Applied Biologist".

Royal Institution (at 21 Albemarle Street, Piccadilly, London, W.1), at 5 p.m.—Mr. G. M. Young: "Equality".

Chemical Society (Sheffield Section) (joint meeting with the Sheffield University Chemical Society) (in the Chemistry Lecture Theatre, The University, Western Bank, Sheffield), at 5.30 p.m.—Prof. W. Wardlaw: "Co-ordination Compounds".

# APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Pests Control Organizer (temporary) for the County of Montgomeryshire—The Executive Officer, Montgomeryshire War Agricultural Executive Committee, County Offices, Welshpool, Mont. (November 7).

Electrical Engineer and Manager of the Metropolitan Borough of Southwark Electricity Department—The Town Clerk, Southwark Town Hall, Walworth Road, London, S.E.17 (endorsed 'Electrical Engineer and Manager') (November 8).

Lecturer (temporary) in Gardening, Biology and Elementary Science in the Caerleon Training College (men)—The Acting Director of Education, Higher Education Department, County Hall, Newport, Mon. (November 11).

Educational Psychologist—The Director of Education, County Offices, Oxford (November 11).

Speech Therapist—The Director of Education, Education Offices, Woodlands Road, Middlesbrough (November 11).

Lecturer in Production Engineering, in Courses (both part-time Day and Evening) leading to Ordinary and Higher National Certificates—The Principal, Derby Technical College, Normanton Road, Derby (November 15).

Drainage Officers (2), and a Water Supplies Officer—The Executive Officer, Shropshire War Agricultural Executive Committee, County Buildings, Shrewsbury (November 18).

Officer in Charge of the Government's Agricultural Training Scheme for ex-Service men and women in the County of Norfolk—The Secretary, Norfolk War Agricultural Executive Committee, Sprowston, Norwich (November 18).

Examiner in Chemistry for the Higher School Examination for the year 1945—The Secretary to the Matriculation and School Examination Council, University of London, at Richmond College, Richmond, Surrey (November 20).

Assistant Lecturer and Demonstrator in Zoology, preferably with special qualifications in Experimental Zoology—The Registrar, University College, Cathays Park, Cardiff (November 30).

University Chair of Concrete Technology tenable at Imperial College of Science and Technology—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (February 26).

Laboratory Attendant in the Department of Zoology—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1.

Laboratory Steward or Laboratory Technician—The Registrar, The University, Bristol 8.

Senior Scientific Assistant in the Department of Economics—The Principal, Harper Adams Agricultural College, Newport, Shropshire.

Manager of the Intelligence Department—The Secretary, British Cast Iron Research Association, Alvechurch, Birmingham.

Agricultural Training Officer to organize the scheme for the training in Agriculture and Horticulture of men and women released from War service—The Secretary, Berkshire War Agricultural Executive Committee, 1 Abbot's Walk, Reading.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

Memoirs of the Cotton Research Station, Trinidad. Series A: Genetics. No. 21: The Inheritance of Lint Colour in Asiatic Cottons. By R. A. Silow. Pp. 39. 2*s*. 6*d*. No. 22: The Genetic Organization of Leaf-Shape Development in the Genus Gossypium. By S. G. Stephens. Pp. 25. 2*s*. 6*d*. No. 23: The Genetics of Species Development in the Old World Cottons. By R. A. Silow. Pp. 16. 2*s*. 6*d*. Series B: Physiology. No. 16: (1) Studies on Foliar Hydration in the Cotton Plant, (iii) Preliminary Observations using the Pruning Method, (iv) The Influence of Composition and Concentration of Nutrient Solution, by E. Phyllis and T. G. Mason; (v) A Further Experiment with Potassium, by T. G. Mason and E. Phyllis; (2) Studies on the Partition of the Mineral Elements in the Cotton Plant, (iv) More about Nitrogen, Phosphorus and Labile Carbohydrate, by T. G. Mason and E. Phyllis. Pp. 42. 2*s*. 6*d*. (London: Empire Cotton Growing Corporation.) [129

# NATURE

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CONTENTS




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## SCIENTIFIC RESEARCH AND PATENTS

IN one of the recent series of articles on "Scientific and Industrial Research" published in these columns, it was stated that "When we have thus provided for the effective organization of research in the universities and under direct Government auspices, there will remain a large field of applied research to be undertaken by private industry". The strategy and tactics of research in each of the three divisions indicated in these words must differ from those of the other two, and the opinion was expressed that while "the funds at the disposal of research are utterly inadequate" and that while there will be required "expenditure ranging up to what might well approach 50 millions", there should be "no direct financial aid to research by private firms". There can be no doubt that Government expenditure on this scale and in this way would be greatly in the public interest and to the social advantage. Nevertheless, the view has been expressed that the extremely large expenditure to which the Government is otherwise committed during the next few years makes it unlikely that it will accept the further responsibility of the suggested £50 millions, without some clear indication of means by which it will be able to cover the expenditure more directly than by some possible consequent benefit to the public interest and social advantage. One way of removing this probable reluctance by the Government would be to stress that industrial development and increased employment result from expenditure on research, to make clear what is at present being achieved in this respect by industry, and to suggest how it can be increased.

The close relationship between industrial development, increased employment, and expenditure on research can be shown by reference to the annual reports of many of the larger industrial companies, and an indication of what is at present being achieved is illustrated by figures recently made public by Imperial Chemical Industries, Ltd. The directors of that company have offered to provide at nine universities of Great Britain eighty fellowships of the average value of £600 per annum to be held by senior workers in certain sciences; the research organization of the Company consists of nearly nine hundred fully qualified chemists, physicists, biologists, engineers, and other scientific men, together with more than a thousand skilled assistants. During 1943, its expenditure on research and development in its own works was approximately £2,200,000; and, in addition, £12,500,000 became due to the British and Overseas Governments under the headings of Excess Profits Tax, National Defence Contribution, and income tax. Similar results on a smaller scale have been recorded by many other companies.

This achievement, so directly beneficial to research in the universities and to Government finance, has been made possible by the industrial use in Great Britain of patented inventions; and it should be remembered that for a patentee to comply with the conditions on which he obtains his patent he must

work his invention in Britain. Patents for the "sole working or making of any manner of new manufacture" were by Section 6 exempted from the statute, passed in the year 1624, for the prohibition of monopolies and, under the present Patents Act, a patent may be held invalid if the invention is not being worked in Great Britain on a commercial scale. In spite of these facts, however, many patented inventions are not being so worked and, in other ways, the monopoly rights are being abused and the public interest detrimentally affected. Any amendment of the patent law which would more effectively compel manufacture in Great Britain of a patented invention, prevent other abuse of the monopoly rights, and increase the incentive to inventors, would develop industry and increase employment, and would incline the Government to give more generous assistance to research.

It would seem that the Government has appreciated this aspect of the matter, because some time ago the President of the Board of Trade appointed a representative Committee, with Mr. Kenneth Swan as chairman,

"To consider and report whether any, and if so what, changes are desirable in the Patents and Designs Acts, and in the practice of the Patent Office and the Courts in relation to matters arising therefrom."

In particular, the Committee is requested to give early consideration to, and to submit an interim report or reports on:

"(a) the initiation, conduct and determination of legal proceedings arising under or out of the Patents and Designs Acts, including the constitution of the appropriate tribunals; and

"(b) the provisions of these Acts for the prevention of the abuse of monopoly rights; and to suggest any amendments of the statutory provisions or of procedure thereunder which in their opinion would facilitate the expeditious settlement and the reduction of the cost of legal proceedings in patent cases and would encourage the use of inventions and the progress of industry and trade."

The Committee is now taking evidence on the two matters on which interim reports are asked for, and this evidence includes memoranda by the Trade Marks, Patents and Designs Federation* and by a Joint Chemical Committee†, consisting of representatives of the more important chemical societies and associations of Britain. These memoranda are drawn up in the form of replies to a questionnaire issued by the Government Committee for the guidance of witnesses and are in substantial agreement on the two matters under consideration.

On the important matter of abuse of monopoly rights, about which there has recently been much discussion in Great Britain and more in the United States, the Federation is of opinion that the complaints made on the score of the operation of cartels in Britain in relation to patents are in general not justified.

* Memorandum on Patent Law Reform. Part I. Prepared by the Trade Marks, Patents and Designs Federation. Ltd., 169 Bank Chambers, 329 High Holborn, London, W.C.1.

† Memorandum on Patent Law Reform. Part I. Prepared by the Joint Chemical Committee on Patents, 166 Piccadilly, London, W.1. 1s.

It is stated that no case is known where patents granted for inventions originating in Great Britain have been operated by a cartel to the detriment of the national interest. It is only in the case of international cartels regulating patent rights originating abroad and owned by German interests that there are recorded instances of operations that are to the detriment of the public interest here. The cases the Federation has in mind are those where there is a written agreement under which the parties agree that manufacture under a patent shall be prevented or restricted in Great Britain in favour of importation. It is recalled that British patents are intended to stimulate British manufactures; and if a patented invention is not being worked in Britain, the patented article being made abroad, for example in Germany, and imported into Great Britain, the whole object of the grant of patents is defeated. Examples are cited by the Federation in support of this view, the most interesting being the shortage of 'Atebrin', urgently required for the treatment of malaria when the sources of supply of quinine fell into enemy hands early in the War. The remedy suggested for this type of abuse of the monopoly rights is to grant licences under a patent to persons who are willing to manufacture in Great Britain and to transfer any subsequent beneficial interest in the patent from the patentee to the Crown.

On the matter of abuses of monopoly rights by the suppression of inventions, so often charged against patentees in the popular Press, the Joint Chemical Committee states that these allegations are usually found on examination to be non-existent or to be due to the abuse of wealth. The remedy lies, in its view, first in the grant of licences in the way just indicated; secondly, in giving the Comptroller of Patents power to refuse, subject to appeal to the Court, to grant a patent for an invention which he is satisfied is lacking in inventive merit or in novelty in view of prior user; and thirdly, in some considerable reduction of the costs in patent actions. Both the Committee and the Federation are of opinion that the attitude of the Courts is too 'legalistic' and not sufficiently 'scientific', and that the reinforcement of the Courts by members with some scientific or technological attainments would be in the public interest. They recommend the appointment of a patents tribunal to include one, two or three High Court judges experienced in patent cases and "one or two lay members selected from a permanent panel of, say, six or eight technologically or scientifically qualified persons" who should not undertake any other employment.

The suggestion for the compulsory licensing of all patents, which has been so fully discussed pro and con during the past two years, is opposed on various grounds. It is pointed out that the reason for granting patents is, as stated in the form of patent, "to encourage all inventions which may be for the public good", the encouragement being the right of sole working of the invention for a limited period. The evidence goes to show that patentees in general value highly this right of sole working, and the opinion is expressed that if, by endorsing patents "licences of

right"; this right of sole working is destroyed, the encouragement of the inventor will to that extent be diminished, the flow of invention will be lessened, and the retention of inventions as secret processes will be increased. As regards the commercial exploitation of inventions, not many manufacturers will be prepared to lay down plant for the commercial exploitation of an invention with the risk that it may be a failure, if competitors are free to obtain a licence should it be a success.

It is clear from the memoranda that the evidence which is being submitted to the Committee appointed by the President of the Board of Trade is such as to strengthen the hope of amendment of the patent law so as more effectively to compel manufacture of a patented invention in Great Britain, and make more readily ascertainable the rights of the public in relation to patentees. By this means industry will be developed, employment increased, and the Government enabled to give more generous assistance to research.

# THE CONTRIBUTION OF SCIENCE TO CIVILIZATION

## Science and the Future

By Prof. A. E. Trueman. (The British Way Series, No. 7.) Pp. 64. (Glasgow: Craig and Wilson, Ltd., 1943.) 1*s*. 3*d*.

## The Impact and Value of Science

By Dr. D. W. Hill. Pp. 88. (London, New York and Melbourne: Hutchinson's Scientific and Technical Publications, n.d.) 7*s*. 6*d*. net.

THERE could be no better tribute to the way in which Prof. A. E. Trueman's "Science and the Future" maintains the standard of the earlier pamphlets in "The British Way" series than the manner in which, without disparaging the British contribution to the advancement of science or encouraging the false idea that there are national brands of science, he justifies the inclusion of a pamphlet under this title in the present series. If the British outlook and way of life are to survive, and to continue to make an effective contribution to the building of the post-war world, due regard must be had to the place of science. It would be difficult to find in short compass an abler popular exposition of just what that contribution might be, and of the difficulties which must be faced in organizing science to secure that maximum contribution without endangering the advance of science itself. Prof. Trueman's exposition of the purposes and needs of the scientific investigator is as valuable to the ordinary citizen as his warning on some of the dangers of planning is to the scientific worker himself. One may fairly regard the whole pamphlet as an important contribution to the debate on the organization of scientific and industrial research from this point of view of exposition, and not merely on the grounds of the brief chapters in which those problems are actually discussed in the pamphlet.

This clear view of the fundamentals gives the main value to Prof. Trueman's pamphlet. His note on the characteristics of the scientific method—careful experiment and accurate observation, verification of the evidence, and the effort to eliminate preconceived ideas and personal feelings in forming a judgment or interpreting results—should help to dispel the idea of mystery with which popular thought sometimes still tends to cloak the man of science. So, too, his insistence on the right of independent inquiry, that science can develop only in an atmosphere of freedom and that the value of the scientific worker to the community lies in his originality, should help the conduct of popular discussion on scientific research —a discussion in which the decisions cannot all be taken by scientific men themselves.

Prof. Trueman's pamphlet should do something to bridge the gap between the scientific man and the ordinary citizen to which he himself directs attention. On this, after noting the cultural value of science, he has a chapter on science in education in which he urges that an outline of science is desirable for the appreciation of the world in which we live. The foundation of the intellectual life of any self-respecting man must be a grasp of the outstanding conclusions of science, and the essential feature of general science teaching is that from it should emerge the general picture of the world as seen by the man of science. Prof. Trueman notes the comparative neglect of science in adult education and by the newspaper Press, and indicates developments in extra-mural classes conducted by the universities and the Workers' Educational Association. In regard to the training of scientific workers themselves, he affirms his belief that an atmosphere of research and the cultivation of the outlook of an investigator are essential features of a university training in science. A combination of teaching and research in one individual, he holds, affords a most effective basis for the training of a man of science. In Prof. Trueman's opinion, a research worker who is not specially gifted as a teacher may be a more effective person to train advanced students than an excellent teacher who finds no pleasure in research.

That proposition may depend on particular conditions, but Prof. Trueman's further view that it is essential that intending teachers should not be cut off from the atmosphere of research but should gain some experience of scientific discovery is likely to command general approval.

Of no less interest to the scientific worker are the sections in which Prof. Trueman deals with the organization of science in Britain and with planning for the future. While he appears to admit that there is a lack of co-ordination in the whole national research programme, Prof. Trueman holds that, so far as the planning of science itself is possible, it can suitably be achieved within the organization already available. In this he is in sharp contrast to Prof. Harold Laski, who in an article, "Research, Intelligence and Administration", in the *Political Quarterly*, argued for major changes. Some of the criticism advanced by Prof. Laski would doubtless be conceded by Prof. Trueman, but the latter's survey is more objective and better balanced, and he has probably succeeded in his attempt to give a reasonable presentation in accord with the views of the majority of scientific men.

In any general plan of research, it is essential to make certain that the whole body of knowledge be kept in growth, and that nothing be neglected because it is not immediately useful. Whatever steps therefore we take to organize the study of particular and urgent problems, we must have the widest possible field for unorganized research workers with

free scope to choose their own problems and to tackle them in their own way. This freedom, coupled with responsibility, is essential whatever the nature of the organization which links the scientific worker with the problems to be solved. Here, no less than in indicating how essential a scientific outlook and a wider scientific education are to the scientific planning of the life of the nation, Prof. Trueman's pamphlet should help to keep discussion on the right lines, and it will be read with interest and profit by scientific workers as well as by the larger body of their fellow citizens to whom it is primarily addressed.

Dr. D. W. Hill covers a wider canvas in his book, though he has much ground in common with Prof. Trueman. He, too, is concerned to interpret the scientific outlook and to emphasize that science is a mental discipline and that its first object is not to control or to exploit but to understand. In a chapter on science and industry, he pleads for a better balance between those who may be classed as technologists and scientific workers and those who understand and can use the tools of company law and finance. Dr. Hill never overstates his case, and his plea that industry needs scientific workers, not so much for their professional knowledge as their ingrained method of thought, is more effective because he sees the limitations of technical skill alone. Sanity of outlook, a balanced judgment, ability to correlate the broadest issues and to see the relevance and implications of widely separated facts, a ranging, imaginative, disciplined mind—these also are wanted, but Dr. Hill never wavers from his conviction that a scientific training can develop such qualities.

This conviction he carries into his discussion of science and politics. Here he is less happy. He recognizes indeed that the full use of the scientific expert involves an educated community: the scientifically trained mind imbued with the idea of freedom of thought, grounded in the system of unbiased judgment, might arrive, after weighing the evidence, at a policy to pursue, but it could appeal only to similar minds for understanding and support. Seeing this, and seeing how easily the absence of such a community may lead to the totalitarian State, he has yet missed the essential element in the democratic system. He sees the affinity between the scientific method and the process of democracy; but much of this chapter is crude and lacks the perspicuity with which Prof. Mannheim and Sir Ernest Barker have discussed this problem in recent years.

No such criticism can be advanced against his discussion of science and war. The issues have rarely been laid bare more discerningly, and this chapter is an admirable reply alike to the loose thinking which saddles science with responsibility that lies on the shoulders of the community as a whole, and as an impetus to the impartial examination and study of the causes of war on which any real attempt to eliminate war must be based. So too in his chapters on science and education and on science and religion, we have a fine plea for educational research, for men with the divine gift of imagination, coupled with the inquiring mind that forces them into research, and men trained to appreciate, to apply and to expound the results of such research; and the conviction that the scientific method must be practised by men of goodwill whose faith in the end they serve is deep-rooted and firm. The hope of this civilization, Dr. Hill urges, lies in the discovery of men in whom the accurate thought born of a scientific training is imbued with the faith that moves mountains in all that is good and operates through a sense of service that outstrips all hope of reward.

Dr. Hill is liveliest in his final chapter on "Science and Leadership", where shrewd criticism of the weaknesses and limitations of scientific men is accompanied by a strong plea for their freer admission to positions of administrative responsibility, and for attention in their training to measures such as wider contacts and interchange of students and of staff which in the formative years contribute so much to widening their outlook. Despite their occasional lapses, Dr. Hill stoutly maintains that scientific workers are more likely to be objective in their judgments than most men, and that the combination of technical skill and knowledge with administrative ability is not rare. Finally, he drives home to scientific workers themselves the lesson that if they are to play their full part in human affairs, they must learn to express themselves adequately, abandon the attitude of aloofness and isolation, and recognize both the limitations of their experience and the importance of those considerations of quality in the realms of human relations, economics and politics, which their preoccupation with quantitative factors is apt to lead them to overlook.

R. BRIGHTMAN.

# SCIENCE IN THE U.S.S.R.: AN AMERICAN SURVEY

Science in Soviet Russia

Papers presented at Congress of American-Soviet Friendship, New York City, November 7, 1943, under the auspices of the National Council of American-Soviet Friendship. Pp. ix+97. (Lancaster, Pa.: Jaques Cattell Press, 1944.) 1.50 dollars.

AFTER the Revolution in Russia in 1917, the United States Government severed diplomatic relations and did not resume them until 1933. To commemorate the ten-year period a meeting of the Science Panel of the Congress of American-Soviet Friendship was held in New York City on November 7, 1943. It was in two parts: one section under Prof. Harold C. Urey dealt with Soviet science and technology, and the other under Prof. Walter B. Cannon with public health and war-time medicine in the U.S.S.R. Fourteen papers were read, each dealing with a particular branch of science, and they are collected in this little volume, "Science in Soviet Russia".

One of the authors, D. Wilder Penfield, of the Montreal Neurological Institute, McGill University, had the advantage of a recent visit to the U.S.S.R. as a member of the Medical Mission that went there in July 1943. He gives a very interesting and well-balanced account of what he saw. He found Soviet war surgery well organized, efficient and modern, and medical education established on a sound and adequate basis. The use of sulphonamides was well understood, as were also plaster treatment of wounds and fractures, provision of blood and blood substitutes for hæmorrhage and shock, and evacuation of wounded by air. The organization of the surgical work was especially good, though in certain refinements of technique there was room for improvement. Medical education has developed rapidly. In 1940 there were 160,000 medical practitioners; in the five pre-war years, seventy-two medical institutes had turned out about 21,000 new ones

yearly: before the War, 50 per cent were women; now the proportion is about 85 per cent. Like others who know them, Dr. Penfield speaks very highly of the efficiency of the Russian women. He praises, too, the nurses, who not only tended their patients but also helped build the huts in which they were to live and work, besides being attractive partners in the dance given to welcome the Mission to a forward hospital. He saw no signs of malnutrition: the ration, he was told, was 1·75 lb. bread daily and 4·4 lb. meat or fish weekly for a worker; and 0·8 lb. bread daily and 1·3 lb. meat or fish weekly for a non-worker or child working less than three hours per day. Prof. Winslow describes what he saw of the work on public health in 1936. The death-rate from diphtheria, the incidence of syphilis, infant mortality-rate and death-rate in the larger cities had all been greatly reduced since 1913, and medical services were being pushed out into the villages as personnel became available. Malaria and dysentery remained as major menaces, but rodent carriers of plague were being dealt with. The outstanding feature of the public health programme was the provision for the care of maternity and infancy.

Two papers were devoted to geology in the U.S.S.R. Dr. Muller mentions the conversion of coal *in situ* into gas, which is then piped directly to the furnaces of industrial plants. British men of science remember with pride that the original suggestion was made by Sir William Ramsay: it was quickly taken up by Lenin, who saw in it the possibility of improving the coal workers' lot; the story has been told by Dr. E. B. Bailey in the *Journal of the Royal Society of Arts* (92, 540; 1944).

Dr. Muller also gives an account of the work on "Permafrost", that is, permanently frozen sub-soil. Prof. Dunbar attended the Geological Congress in Moscow in 1937 and quotes figures showing the remarkable increase in mineral output:

| | 1921 | 1927 | 1937 | 1940 |
|---|---|---|---|---|
| Aluminium | — | — | 37,000 | |
| Copper | 2,000 | 12,000 | 92,000 | 125,000 |
| Pig iron | 112,000 | 2,900,000 | 14,520,000 | 15,500,000 |
| Manganese | 29,000 | 840,000 | 2,750,000 | |

Dr. Waksman deals with bacteriology in the Soviet Union, a subject on which he has encyclopædic knowledge. The great pioneers were Metchnikov, who worked on medical bacteriology at Odessa, and Siergei Winogradsky, whose investigations in general bacteriology were made at the Academy of Medicine, St. Petersburg. Subsequent developments in these directions are indicated, the names of the investigators and a brief statement of their contributions being given.

Dr. Stanley describes Soviet studies on viruses in an account which is the more interesting because he concentrates on a few important papers by Ivanovski, Rishkov and Goldin, and indicates only in a list of references the subsequent developments.

Brief sections on electrons and on soil and agriculture complete the book.

It is interesting to compare the American evaluation of the scientific work with the British. We should certainly have included a section on chemistry so as to include accounts of the work of Semenov, Frumkin and others, and mention would have been made of the mathematician Vinogradov, the physicists Joffe and Kapitza, the agricultural botanist Lysenko and the soil scientists Dokuchaiev, Glinka and Polynov. Yet none of these names occurs. The book has the same title as one by J. G. Crowther, published in 1930, and a comparison of the two shows something of the change in the last fourteen years. In some way or other, British scientific workers must learn more about what their Russian colleagues are doing. Admittedly the difficulties are considerable. It is too much to expect British scientific workers to learn Russian on any extensive scale, and it is unfair to Russian science to judge the papers solely by the short summaries in English given at the ends. Perhaps the best way to ensure a proper appreciation of the work would be to arrange for the publication of systematic accounts of specific subjects, somewhat on the lines of those issued from time to time by the Imperial Bureaux of Soil Science and of Plant Genetics, and of translations of specially important papers. E. JOHN RUSSELL.

# INDUSTRIAL HAZARDS

## The Analytical Chemistry of Industrial Poisons, Hazards and Solvents

By Dr. Morris B. Jacobs. (Chemical Analysis: a Series of Monographs on Analytical Chemistry and its Applications, Vol. 1.) Second revised reprint. Pp. xviii+661. (New York: Interscience Publishers, Inc., 1944.) 7 dollars.

WHETHER we work in office, shop or factory, with hand or brain, we are exposed throughout life to a number of hazards quite outside the powers of the police to prevent. Such hazards are detected by workers who wear no uniform unless it be the white coat of the laboratory, and come under the general heading of industrial hygiene. There is ever-increasing need for their watchfulness as industry and life grow more complex. Industrial poisons, gases, dusts, vapours of solvents, lurk around the corner ready to attack us once or repeatedly until we fall sick or lose our working efficiency.

The public has little knowledge of the extent to which they are guarded, while those who act as guardians are conscious of how much more remains to be done in the nature of staff and equipment.

Any new subject demands new methods; in general these have to be quick and simple. Hence the desire on the part of the author, who is senior chemist to the Department of Health in New York City, to bring together the analytical chemistry of industrial hygiene. He has produced a bulky volume, for such instructions, if they are to be explicit, have to be given in considerable detail. Workers in the smaller laboratories faced with the same multitude of problems as in a large city have little time to search for the best methods of attack or to devise new ones and will therefore be glad to have a book in which they are detailed.

The headings adopted for the detailed treatment are sampling—never an easy task—the measurement of gas volume and quantity, absorbers and absorbents. Then follows a description of the chemical and microscopic estimation of dust and silica, of the dangerous and other metals, of the common poisonous compounds of sulphur, nitrogen and phosphorus, the halogens, carbon compounds like carbon monoxide, hydrogen cyanide, etc. Further sections deal with organic compounds, particularly the growing class widely used as solvents. Lastly, the chemical warfare agents have to be considered, a necessary though tragic precaution in these days.

It would be unfair to criticize any of the methods on points of detail—they have all been tried out in the laboratory and serve their purpose. What is important is that their listing will save an immense amount of time for other workers.

Our life in the factory, even in travel to and from work, exposes us to hazards which we fail to appreciate until afflicted with some ailment which our medical adviser finds hard to diagnose. Acute poisoning is generally accidental and obvious, but the effects of slow and chronic poisoning are more deep-seated and often much more damaging. Once the causes are diagnosed and understood they can be removed, but to do this requires much careful work on the part of the chemist.

Chemical warfare agents are unlikely to be experienced in the United States as the result of enemy action, but during their manufacture and subsequent processing they do present serious risks. Many of them are hazards met in industry under another guise, either as industrial products like chlorine and phosgene, as by-products, or as decomposition products of other substances. It is a growing practice, for example, to transport chlorine and ammonia in tank wagons holding tons, or containers of several hundredweight capacity: a spill in transit might have most serious consequences, killing or injuring people over a wide area. A recent issue of a New York journal gave an alarming picture of an actual incident. 'Warfare agents' are also being developed for peace-time uses as fumigants, insecticides and even for extinguishing fires and refrigeration. A careful watch will have to be kept that rigid precautions are taken both in manufacture, storage, transport and use of such chemicals. In passing, it may be noted how few noxious chemicals are of any value in war: of more than three thousand substances tested less than a dozen were of any importance as warfare agents.

Incidentally this is the first of a projected series of monographs on analytical chemistry and its applications.

E. F. ARMSTRONG.

## CONTROL OF BACTERIAL ENVIRONMENT

### Micrurgical and Germ-Free Methods

Their Application to Experimental Biology and Medicine; a Symposium. Edited by James A. Reyniers. Pp. xiv+274. (Springfield, Ill., and Baltimore, Md.: Charles C. Thomas, 1943.) 5 dollars.

IN November 1939 a colloquium was held in the Laboratories of Bacteriology of Notre Dame University to discuss micrurgy, or microscopic surgery, the cultivation of plants and animals in the absence of bacteria, and the control of aerial cross-infection in hospital wards. The papers which were contributed are now published in an attractive book, profusely illustrated with good photographs and diagrams, with a common index at the end, and generous bibliographies for each contribution.

Three papers deal with micrurgy. James A. Reyniers describes and discusses the design of machines for making single-cell cultures of bacteria and spores. Various ingenious devices are presented; the paper is entirely technical. M. J. Kopak describes the technique of measuring surface tensions and the behaviour of oil-water interfaces inside cells by injecting small drops of oil into them through micro-pipettes. The hydrostatic pressure necessary to form the drop gives a measure of the oil-water surface tension. An oil drop formed at the point of a micropipette in a watery protein solution collects protein molecules in its surface; if the drop is sucked back into the pipette, the area of the surface film decreases and the protein molecules are compressed until a critical drop size is reached, when the compressed surface film wrinkles—the Devaux phenomenon. Observation of such drops in watery protein solutions, in disintegrated protoplasm and inside living *Arbacia* eggs, provides evidence concerning the state of proteins in living protoplasm—a subject which the author discusses. E. M. Hildebrand contributes a review of all the uses to which micrurgy has been put in botany.

The remaining eight papers deal with germ-free methods. Reyniers describes his system of closed apparatus in which germ-free vertebrates, born by Cæsarean section or hatched from germ-free eggs, can be reared, fed, watched and inoculated. Guinea pigs and chickens, completely free from bacteria, have been kept alive and healthy for six months. Two Rhesus monkeys were similarly raised; one died from an accident after forty-five days, the other was still alive and well after four months.

Oram C. Woolpert and N. Paul Hudson contribute a review of the use of the mammalian fœtus as an experimental animal in bacteriology, virology and immunology, and discuss the technique of intra-uterine inoculation.

R. W. Glaser, in a paper on the germ-free culture of certain invertebrates, describes methods of obtaining germ-free strains by multiple washing of Protozoa, or of the eggs or larvæ of worms or insects, with or without the use of bland disinfectants. Complex machinery is not needed. The chief difficulty is to devise suitable culture media on which germ-free strains can be grown. Certain Protozoa which are strongly geotropic can be made to swim clear of the bacteria which usually contaminate them. The germ-free method is particularly useful with certain parasitic species, cultivation of which in the past has generally failed on account of bacterial contamination. For example, germ-free cultivation of *Neoplectana glaseri*, parasitic on the Japanese beetle, *Popillia japonica*, has made possible mass cultivation of infective nematodes which can be used in the field to control the beetle. *Hæmonchus contortus* of sheep has been cultivated *in vitro* through some of its parasitic stages. Among insects, *Aedes ægypti* and *Musca domestica* can be bred indefinitely, by methods described in the paper, quite free from bacterial contamination.

Philip R. White discusses the cultivation of germ-free plants or parts of plants. The principles of technique resemble those applying to invertebrates. Sound aseptic practice is the main necessity, given which it is often possible to obtain uncontaminated cultures from growing tips, or from seeds in their fruits or pods, which are naturally germ-free.

The three remaining papers deal with control of the bacterial environment of man; or rather, with that of infants in hospital wards. James A. Reyniers describes a cubicle which he has devised in which infants can be raised without risk of aerial or contact cross-infection. By placing the infant in one cubicle, and the nurse who looks after it in another alongside, and controlling the ingress of bacteria to both cubicles by the usual aseptic methods and by regu-

lating air pressures so that the flow of air is always away from the infant, Reyniers considers that a mechanical system of barriers to cross-infection can be erected. I. Rosenstern and E. Kammerling describe an experiment designed to compare Reyniers' mechanical method of cubicle isolation with Wells' ultra-violet light barrier isolation method, and with ordinary air-conditioning as a control. Each system is being tested on a block of twelve cubicles at the Cradle, Evanston, Ill., the three groups of infants being comparable in point of age, general health, and respiratory infection rate. The result of the experiment is not recorded, but the authors give details of preliminary bacteriological tests made by spraying *Chromobacterium prodigiosum* into the air and following its distribution.

The last paper is a detailed description by William F. Wells of his method of reducing the bacterial flora of hospital air by means of ultra-violet light screens.

The greater part of all of the papers is devoted to technique, but the authors also discuss the many uses to which the methods they describe may be put.

## PRACTICAL MALARIA CONTROL

**Practical Malaria Control**

A Handbook for Field Workers. By Dr. Carl E. M. Gunther. Pp. 91. (New York: Philosophical Library, Inc., 1944.) 2.50 dollars.

THE title of this book is an ambitious one, and our appetites are sharpened by the reputation of the author as an entomologist of repute, one fully acquainted with the literature of malaria, with practical experience in the field, as well as in the laboratory. In performance, however, the result is a little disappointing. The style is somewhat involved and confused, and the author has failed to make the most of what is a great opportunity. Many of the statements are dogmatic and open to criticism. For example, it is recommended that in conducting a malaria survey the best method is to collect adult *Anopheles* and post them to the nearest school of tropical medicine, or even the British Museum, for identification. At this point the student is left entirely in the air with the advice that no useful purpose can be served by detailing special control methods applicable to individual species of *Anopheles* which constitute the whole basis of species sanitation.

Under personal measures, the author declares himself a zealous advocate of prophylactic quinine, and, because of the excellent results he has obtained, insists on its use by every member of the non-immune population more than ten years of age. For small children quinine prophylaxis is not advised, as tending to produce the typical thin, pale and languid 'tropical' child. It will be noted that distinctions are drawn between measures applicable to those who are immune and those who are non-immune to malaria.

The author's brief instructions on the control of malaria in military campaigns can scarcely be of practical value under present war conditions.

The clinical section suffers from generalizations, and no attempt has been made to distinguish clinical syndromes produced by different species of *Plasmodium*, but one can infer from the sense of the text that the subtertian form is the one with which the author is most familiar. In treatment the author is by no means enthusiastic about 'Atebrin'; he prefers intramuscular injection to oral administration. When given by the mouth 'Atebrin' is, he avers, erratic in action, while 10 per cent of patients are highly sensitive and suffer from poisoning which is marked by "racking intractible bilious vomiting" lasting 12–14 hours. The treatment of blackwater fever does not follow on generally accepted lines; there is, for example, no evidence that blood transfusion aggravates intravascular hæmolysis. P. MANSON-BAHR.

## THE BACKGROUND OF IMMATERIALISM

**Immaterialism**

Annual Philosophical Lecture, Henriette Hertz Trust, British Academy, 1944. (From *Proc. Brit. Acad.*, 30.) By Dr. A. A. Luce. Pp. 16. (London: Oxford University Press, 1944.) 2*s*. net.

IN this lecture, given before the British Academy, Dr. A. A. Luce comes forth as an explicit defendant of the doctrine that there is no such thing as matter. There are periods in the history of philosophy when immaterialism becomes fashionable. Bishop Berkeley, in his "Principles", and Collier, in his "Clavis Universalis", arrived independently at the doctrine in the early years of the eighteenth century. Dr. Luce's lecture throws great light on the intellectual soil which gives rise to such a doctrine.

Just as Berkeley started from Locke's position that "all our knowledge is by way of ideas", so Dr. Luce starts from the position of Moore, Russell and Broad—in principle the same—that all our knowledge is by way of sense-data. Hence he substitutes for the question "Does matter exist?" the question "Is there material substance *over and above the sum total of sense-data*?" The negative answer which he gives to the second question has no tendency to show that matter does not exist except to a believer in sense-data.

As soon as philosophers analyse experience into components, whether ideas or sense-data, matter cannot be found; it lingers on only until someone like Bishop Berkeley or Dr. Luce gets up to say that, as it cannot be found, it would be as well not to keep on talking about it.

But the fault may lie in the original analysis, which omitted something of importance. Dr. Luce says: "When in Boswell's presence Dr. Johnson kicked the mighty stone and 'refuted' Berkeley, he was simply appealing to what he could touch and see, i.e. to sense-data and *sensibilia*, and if that be all that is meant by 'matter', any reasonable immaterialist would accept it" (p. 6). This way of dismissing Johnson's refutation under-estimates the innate good sense of that mass of English judiciousness. It is possible that Dr. Johnson was appealing not to sense-data but to a quite different experience, namely, a direct awareness of another body opposing my body, in which the sensations of touch are merely episodes, featuring in, but not exhausting, the total experience. If so, this kicking of the stone was a valuable commentary on a missing element in all such theories as Berkeley's. Those philosophers who speak of sense-data as 'presented' to us or as 'presentations' forget this element and talk as though life was like a cinematograph film unrolling before us, instead of what it is and is felt by us to be, an interaction of bodies. If we surrender this point, we surrender matter. WINSTON H. F. BARNES.

## John Dalton

Some Unpublished Letters of Personal and Scientific Interest, with additional Information about his Colour-Vision and Atomic Theories. By Dr. E. M. Brockbank. (Publications of the University of Manchester, No. 287.) Pp. ii+62+5 plates. (Manchester: Manchester University Press, 1944.) Cloth, 7*s.* 6*d.* net; boards, 7*s.* net.

DR. BROCKBANK'S modest booklet, dated on the centenary of Dalton's death, does not bring forward any new material of primary importance bearing upon the philosopher's life and work; nevertheless, it will be welcomed by all who are interested in Daltoniana. It contains notes on Dalton's family history, on the Kendal and Manchester periods, on his appreciation of female society, and on his relationships with the Society of Friends and with Peter Clare, together with nine hitherto unpublished letters. There are also short chapters on colour-vision defects and the genesis of the atomic theory. It is revealing that Dalton found Boyle's style "so tedious and verbose" in his chemical tracts "that one cannot reap the full advantage from them, except they were condensed and digested a little better"; at the same time (1790) he regarded Boerhaave's "Elementa Chemiae", published in 1732, as "a capital" treatise, and approved also of the "essays of the present Bishop of Llandaff" (Richard Watson). Among other interesting details we may note that early in his career Dalton gave tuition for so little as a shilling an hour; that in 1792 he found London "a most surprising Place to a Stranger"; and that although he was often regarded as a gruff disciplinarian, somewhat uncouth or even morose in manner, yet in his younger days he used to write extempore verses in the diaries of his lady friends. J. R.

## International River and Canal Transport

By Brig.-General Sir Osborne Mance, assisted by J. E. Wheeler. (International Transport and Communications.) (Issued under the auspices of the Royal Institute of International Affairs.) Pp. viii+116. (London: Oxford University Press, 1944.) 10*s.* 6*d.* net.

INLAND waterways have always been important lines of communication and transport, and the tendency in recent years has been to increase their use by canalization and control of flow, as their value is enhanced by hydro-electric schemes. But this new value of flowing water raises many acute problems of international control, since the most important rivers are seldom confined to one State.

Sir Osborne Mance has rendered considerable service to the river problems of to-morrow by compiling a general survey of existing international river arrangements with special reference to Europe. These arrangements will not necessarily remain, but they indicate many of the problems that will shortly have to be faced. The Rhine, Danube, Elbe and Vistula are four rivers that are hedged around with problems of this nature, each being vital to the well-being of more than one State.

It is a pity that the pamphlet gives little or no account of the depths, flow, width and lock systems of the rivers and canals, since these considerations obviously affect the problem. There are two rough sketch-maps showing the main waterways, and projected canals of central Europe.

But surely the price is high for a pamphlet of little more than a hundred pages.

## The Application of Radiant Heat to Metal Finishing

A Critical Survey of the 'Infra-red' Process for the Stoving of Paints and Enamels. By Dr. J. H. Nelson and H. Silman. Pp. viii+79. (London: Chapman and Hall, Ltd., 1944.) 8*s.* 6*d.* net.

THIS useful little book is very rightly critical of the indiscriminate use of the term 'infra-red' to describe radiant heat sources, for one cannot but be amused to see a battery of brightly incandescent lamps referred to as an 'infra-red' lamp heating plant. After a short introductory chapter on radiant heat and its advantages, the authors describe the principles of heat transfer, giving the physical laws pertaining thereto and an elementary treatment of some of the mathematics involved. Thereafter, the study is essentially of a practical nature and includes the history of the 'infra-red' process, reflectors, plant construction and design, paint formulation and the field of application of radiant heating.

It is pointed out that while considerable progress has been made in the practice of radiant heat applied to the stoving of paints and enamels on metal surfaces, rapid developments in technique are to be expected in the very near future.

The book can be recommended to those needing guidance on the subject.

## Direction Finding by the Stars

By J. B. Sidgwick. Pp. 88. (London: Faber and Faber, Ltd., 1944.) 5*s.* net.

MR. SIDGWICK'S little book provides much useful information for those who have only a rudimentary knowledge or no knowledge of the constellations and chief stars. Starting with the Great Bear, which most people recognize, directions are given for finding and recognizing the other constellations which appear at the different seasons. The stellar bearings are easily found from a date table and a number of graphs, and the use of the table and graphs is illustrated by examples which are fully worked out. Even the novice should find no difficulty in applying these to obtain his bearings if he carries a copy of the book in his pocket. In addition to finding one's bearings, directions are given which enable the reader to determine the time by means of the sun and a number of the brighter stars. Soldiers on active service will find much useful information in the book. M. D.

## Good Soil

By S. Graham Brade-Birks. (Teach Yourself Farming Series.) Pp. 296. (Bickley: English Universities Press, Ltd., 1944.) 3*s.* net.

SOMEWHAT more academic than are other volumes in this series, this book covers a good deal of ground in small compass and presents an invaluable introduction to soil science—though possibly the section on cartography could have been fuller. The book is especially notable as making accessible the details of Dr. Linwood L. Lee's New Jersey method of recognizing textural groups by handling the soil, for its numerous and instructive illustrations, and for its useful outline of soil mineralogy. The book pays special attention to soil texture, describes world soil groups ("the soil-pattern of the world"), and has a practical chapter on finding the best crop for every soil under English conditions.

It can be cordially recommended to biologists and non-biologists as a clear exposition of a subject about which few books exist.

# FUTURE OF BIOLOGY IN WORLD AFFAIRS*

By Dr. FRANS VERDOORN

DURING the last months of the War of 1914–18, a period which—from many points of view—may be compared with the present, the plant scientists and zoologists of the world were less involved in the war effort than they are to-day. Nevertheless, as such addresses and papers as Lyman's "Contributions of American Botanists for More Active Prosecution of War Work" (1918) and Stevens's "American Botanists and the War" (1918) show, some of the foremost plant scientists of the United States were prevailing upon their colleagues to engage in activities which might help the war effort. At the same time much consideration was given to the War from a biological point of view, as such publications as Nicolai's "Biology of War" (1919) and Pearl's "Biology and War" (1918) testify. Just before the end of the War many interesting papers on the role of botany and biology in the post-war world were published. These included "Botany as a National Asset" (Coulter, 1917) and "Botany after the War" (Davis, 1918), and were followed by an unusual number of inspired discussions by men like Lyman, Peirce and Gager. Though during those years a number of biologists did accomplish useful things in such fields as pioneering in dehydration, raising the agricultural output and discovering substitutes of vegetable origin, the foremost trend of thought, especially in the Allied countries, was concerned with biology in the post-war world, in human relations as well as in agriculture, etc. The Germans of that time were, comparatively, much more concerned with problems directly relating to the war effort than were their colleagues in the Allied countries. Diels wrote an entire volume on botanical substitutes; Haber and other chemists revolutionized the fertilizer situation.

In the discussions in Allied countries the educational and humanizing value of biology was stressed much more than it is to-day. Many believed that a better knowledge of, and better training in, biology might well revolutionize the citizen's attitude towards essential problems of life and human relationships. This hope has not materialized—and that, without doubt, is a reason for the sceptical and negative attitude of many of us to-day.

In one field, however, enthusiasm, understanding and leadership on the part of the biologists of the Allied countries was scarcely progressive. It strikes the historian as strange that in those Wilsonian years very little was said, in either British or American discussions, about international work and relations in science, the re-establishment of international relations, etc. There was a much more patriotic (though not a soundly patriotic) tone in the discussions then than there is to-day, when it looks as though groups of men of science (not necessarily natural scientists) in Great Britain and the United States are at least as much interested in post-war international relations as are the large political groups. It was in 1919 that Livingston turned down Lotsy's generous offer to combine the planned *Botanical Abstracts* with the *Botanisches Centralblatt*, at that time—in spite of its name—a purely international journal and the official organ of the now defunct International Association of Botanists. This rejection killed that Association and much that it stood for, and postponed for years a resumption of international relations work in botany, so enthusiastically started before the War of 1914–18 by men like Scott, Goebel, Farlow, von Wettstein, Trelease and many others.

When war broke out in 1939, international relations work in science had not yet fully recovered, nor by any means reached the status of 1914—this in spite of the many congresses, meetings and commissions in our field about which I have reported in great detail, in an effort to stimulate interest in them, in special sections of *Chronica Botanica*, volumes 1–3. Reading those reports of the years before the present War and comparing them with those during 1912–14 creates the conviction that an unsound impetus was given during the years just before this World War by motives only slightly differing from national propaganda.

In this War the biologist has played a much larger part than in any previous war. Botanists, agronomists, zoologists, entomologists, psychologists and bacteriologists have contributed in larger numbers and in more intensive ways than ever before to the war effort. Men of science form one of the few groups in society which know that the concepts and ideas by which politicians and the accepted organizers of human relations are guided are mostly wrong, based on misconceptions, old superstitions and false intuitions. Yet the man of science has left not only the administration, but also most of the study, of the administration of human life and world affairs in the hands of people who are not very appreciative of what a century of progress in the science of life has achieved. Therefore, I cannot help feeling that men of science are more truly responsible for the chaos of to-day than any other part of society.

The resources, strength and endurance of the United States, the British Empire and the U.S.S.R. and their allies are bringing this War to an end, an end which will place the man of science once again in a very favourable position, as he will remain free in the post-war world, not in all but in much more than half of the Allied territory. How will he use this freedom of thought and action?

I want to begin a discussion of the peace tasks of the man of science with a most difficult problem, which logically does not come first at all. Yet it is so important and most of us are so consistently dodging it that I feel I must bring it up before anything else.

When we speak of the re-establishment of international relations, I believe that most of us think primarily of Great Britain and other Allied countries. Most of us do not think clearly about *the re-establishment of relations with the present enemy countries*, especially with Germany. Yet there can be no doubt that it is essential that workers in science, the humanities, and the arts understand that they are the members of society best fitted to pioneer in the re-establishment of relations with the enemy and that it is necessary for them to prepare to do so at short notice. Intellectual life, as Raymond Fosdick has said, is the most fundamental unity of modern civilization, and that life cannot be broken in parts without disaster. This is the most obvious reason, clear to anyone, for a demand for a quick and thorough re-establishment of international relations

* From an address entitled "The Plant Scientist in the World's Turmoils", contributed by Dr. Frans Verdoorn (of Arnold Arboretum and editor of *Chronica Botanica*) to a symposium on "Biologists and Rehabilitation" held by the Botanical Society of America and the American Association for the Advancement of Science at Cleveland, Ohio, on September 13.

in science and the humanities. But there is another reason with which not everyone may agree as quickly but which seems to me at least as important. Peace, progress and human well-being generally depend upon the integration of present enemy countries in some system of full international co-operation. Biologists know that our world needed millions of years to develop to its present status and that it will need some time to develop into a commonwealth of nations. Yet the trend of the development of mankind is in that direction, and the groups best fitted to do so have to go ahead and assume leadership. The necessity for this was expressed in more detail already early during this War by a manifesto of fifty-seven members of the Royal Society of London. It is the duty of the men of science to the world—and therefore also to their own countries—to re-establish relations with enemy colleagues *both* individually and through meetings, congresses and international commissions, *in all fields* (also where the activities of many Allied research workers are controlled by trusts) to the fullest possible degree and as soon as circumstances permit. We must do this whatever practical commands for dealing with Germany, German split States, etc., may be, in order that the German man of science will not 'go underground'. The world of science needs him, but the world at large needs him still more. The mistakes made after the War of 1914–18, when most international co-operation in science was started in France, more by politicians than by men of science, and restricted to Allied and neutral countries, must not be repeated, even though we know that some of our enemy colleagues will use purely scientific co-operation for other purposes.

To enter again into mutually useful relations with colleagues in enemy countries, it will be necessary to realize that some of them think as we do, but many of them do not. To deal with these men it is necessary to realize that the Totalitarian State, in which the younger ones especially believe and may continue to believe, is a form—evil, we may think—of world evolution. It has enabled men, men of science, social workers and others to do things in science, research, teaching, social applications, etc., which are not necessarily evil—as is often tacitly assumed only because they were made possible by a Fascist Government. Especially in the biological and agricultural sciences much that was excellent was done during the pre-war years in the Axis countries. Study, understanding and realization of these things is a necessary basis for a good programme of the re-establishment of relations, 're-education', etc. The politician, let us never forget, has to emphasize what divides; the man of science may well emphasize what unifies. Workers in pure and applied biology are in a specially favourable position to pioneer in this field. The problem of intellectual relations with Germany demands more than goodwill; it asks for effort and study.

Speaking of agriculture in the post-war world, Dr. Auchter, of the U.S. Department of Agriculture, in a recent address emphasized (1) improved nutrition for human beings, (2) methods of breeding and the use of substances that regulate growth, (3) world exploration to obtain and maintain material for breeding purposes, (4) the changed fertilizer situation, (5) utilization of waste and by-products, and (6) problems of insect and disease control. To them I should like to add research in a field about which we heard more at the end of the War of 1914–18 than to-day. In spite of the lack of emphasis on international relations at that time, there were in the minds of our colleagues, a generation ago, a number of ideas, or rather a feeling, for the necessity of closer relations between science and government (not necessarily human politics). We might call this borderland biopolitics. I miss a plea for it to-day. Is it because we have despaired of ever establishing such relations? Or is it a reaction against the close relations between biology and politics in the U.S.S.R. in which biology has occasionally been reduced to serfdom? If that is so, a word of warning must be expressed. To do so I just used the word *biopolitics*, which will recall a related field of research, *geopolitics*, developed by and first used in the Axis countries, but, once again, not evil on that account, as shown by the ways it is now being developed along purely scientific channels by American scholars. Biopolitics and geopolitics may well be the ways along which men of science will find it possible to reach those groups which they hitherto failed to influence.

It is not true that the two World Wars are simply conflicts between have and have-not nations; yet the conflicts between these two groups are more responsible for the twentieth century chaos than are any other conditions. The practical politician will deny this vehemently; the man of science knows better. H. G. Wells in 1940, in "The New World Order", considered it the second most important of the four major causes of war. The man of science, the only reliable authority on natural resources and the possibilities of their development, may well contribute a major share to the establishment of a durable peace. He also knows that a durable peace will have to be plastic—a consideration which the practical politician again considers absurd.

One of the resolutions of the United Nations Conference on Food and Agriculture states: "The natural sciences are a particularly fruitful field for international co-operation because they are themselves international; basic physical and biological laws are the same anywhere and universally accepted". This is true, but it is also true that co-operation demands an attitude which is not typical of the average biologist. Considering the matter psychologically, most of the better workers in botany and zoology turned to this pursuit because early frustrating experiences resulted not in the normal, human response of aggression, but in a desire for isolation. It is perhaps a bit hard to demand now that these men become enthusiastic co-operators. We will, however, have to assume that at least some of them have learned that even in a Nature research it is true that 'united we stand, divided we fall'.

Sometimes I speak of plant scientists, sometimes of biologists, sometimes of botanists. This inconsistency is not due to carelessness, but to a tragic fact, to the greatest professional problem we have: there are no longer biologists or even animal scientists and plant scientists.

There was a discussion some months ago in the columns of *Science* about whether there still exists to-day such a subject as biology. Some of the writers stated that it was a fraud to speak of biology any longer, as we always mean something else. There is, of course, such a subject as pure biology when considered from a purely scientific or philosophical point of view, but there are no longer professional biologists. There are only specialists in the various branches of the pure and applied plant and animal sciences. What makes it bad is that these specialists do not keep together or think and plan together

with reference to their professional interests as medical and chemical workers do. Though very large in number (22 per cent of the men of science included in "American Men of Science" (ed. 7) are "Biologists" *sensu antiq.*), our position both as a group and as individuals is extremely weak. As wage earners we are in many cases not able to give our families the comforts and education which we received in our youth or which the families of our friends in college receive; as men of science we have either to teach or to work in applied biology, with the result that many branches, especially of descriptive biology, have an anachronistic status; as a group we cannot exercise an influence commensurate with our knowledge.

*Mutatis mutandis*, this situation is the same all over the world. From this it appears that the situation is the result of internal factors, and that it cannot be changed easily, for example, by establishing professional biological societies, unions, etc., especially not so long as—another curse of biology—its great men of science continue to refuse to give professional guidance.

With every generation an increase in specialization seems to become necessary. This may be really essential, but the result is that many workers spend their enthusiasm and greatest mental output in their youth, and end with years of not-too-inspired routine research. Great as the literature and body of facts of any branch of biology may be, I do not agree that all this specialization is necessary. The organization of most of our institutions is such that it forces the so-called free worker into a steady and dull routine.

We all, but the administrators of research especially, should distinguish between deep and permanent specialization. But even if we feel that permanent and deep specialization is necessary, can we not educate our pupils with the feeling that they are in the first place biologists, whatever they do, and specialists in some branch of the pure or applied plant or animal sciences in the second place? No improvement of the status of biologists is possible if they do not recognize the very close interdependency between pure biology and applied biology on one hand, and between biology and world economy and government on the other hand. Also all biology, in contrast to physics, mathematics, etc., continues to have close ties with the humanities. We cannot fulfil our mission if these facts are disregarded; we cannot raise a satisfactory crop of young biologists if we and they are not governed by this knowledge.

Now let us consider the aims of international co-operation in science:

(1) The exchange of information (scientific, professional and practical) in such a way that it will be available to anyone who can profit by it.

(2) The attainment of objectives which individuals or men of science of a single institution or nation cannot accomplish. These may be either in pure or applied scientific research, or they may be co-operative scientific or practical publications.

(3) The forming of an *esprit de corps* which may, at least at some time and at some place, counteract the evils of human international politics and contribute towards the establishment of a commonwealth of nations.

How can we best accomplish these aims?

(1) By the oldest and most important form: the publication of original research, in which every man of science takes part, uninterrupted even by war, every time he has an article or a book published. I find an increasing assumption that scientific publications, not research or knowledge, are the most important thing to-day. We all know that the number of publications is increasing more rapidly than our real knowledge. In two fields with which I am familiar enough to express a judgment, bryology and history, about half the papers of the last forty years have brought only material that needs revision, checking or completion, and that does not really, or only very immaterially, add to our knowledge. Many workers in these fields die without ever having contributed anything to the real advancement of their chosen field. A single monograph, a single well-planned handbook, could have been prepared in the same time now wasted on many little papers. Unfortunately for many of us, the question no longer seems to be how to contribute best to the advancement of science (the fact that many of us can contribute better to our science as a whole by various forms of organizing work is also too often forgotten), but how to make the best impression.

(2) By abstracting journals, international as well as regional.

(3) By international congresses and meetings.

(4) By international societies or commissions, responsible for the organization of international co-operative research. In biology most research is individual, or at most institutional; whereas in other fields of science, for example, astronomy and geodetics, research has developed markedly along lines of direct co-operation, national and international.

Though it is clear that most research in biology will remain quite individual (this should be recognized as the cause of the comparative lack of interest of many foremost biologists in international relations work), there are many scientific and especially applied scientific problems which could more easily and better be solved by some form of international co-operation. In taxonomy, for example, the terrible status of exotic cryptogamic taxonomy cries for some kind of concentrated attack; in plant pathology, a study, on an international basis, of the methods of disease control is greatly desired; in horticulture, an international centralization and further experimentation on the results obtained by the use of hormones in propagation has been asked for by the Permanent Committee of the International Horticultural Congresses.

(5) By international societies or commissions responsible for the organization of practical international activities. In botanical and zoological nomenclature the need for such co-operation was felt at so early a time that much has already been accomplished in this field. There are, however, many other things which could and should be done in the same way: the unification of botanical terminology, colour codification, etc. Such work as has been initiated by Prof. Record's International Association of Wood Anatomists could usefully be done in many other fields. A special war-time problem—and an immense one—is the reconstruction of herbaria and botanic gardens destroyed during the War; this is an international, not a national, task.

(6) By publications not reporting the results of scientific research (either in original form or in abstracts), but bringing together various kinds of information and intelligence. In some cases these may be only stimulating; in other cases, of direct use for the research worker. Publications of this type have played a great part in biology; and I have always been especially interested in them. We may distinguish:

(a) Address-books, either the old-fashioned lists of research workers or the more modern combination of such lists with a census of current research.

(b) Indexes of various kinds; for example, the *Index Herbariorum*, started by Dr. Hitchcock and now actively continued by Dr. Lanjouw.

(c) Such journals as the early *Botanische Zeitung*, early *Botanical Gazette*, *Dörfleria*, the *Chronica Botanica* when it was published as an "International News-magazine". Such journals which bring together various kinds of information and intelligence, discussions, notes, news, etc., have in the past always been published by individuals who after some time could not continue to give them the necessary time and money. They should, of course, be the official professional organ of an international society.

(d) A very great need exists also for a new and complete guide to the literature of the plant sciences. This also will be possible only with international co-operation.

(e) Then there are many publications, semi-scientific, semi-practical, like the "Index Kewensis" and "Index Londinensis" and my planned "Index Botanicorum", which were formerly compiled on an institutional or national basis, but which, in the future, will probably ask for an international effort.

None of these things in itself is very important, but together they make a complex mass of activities both inspiring and helpful, and well worth the effort, even if we realize that to do this work well some of those who will do it will have to give up projects in pure research dear to their hearts.

Just as a commonwealth of nations, the goal of almost all thinking men, is not yet in sight, it is clear that the time for some of the activities just enumerated is not yet here. The tendency of human development, in any field whatever, is, however, toward greater unity. Before there can be anything like a world-embracing commonwealth of nations, regional commonwealths may be more immediately feasible. Pan-Europe as planned by Briand and Coudenhove Kalergi is one of them; a united Western Hemisphere as planned by Simon Bolivar and Henry Clay, and to some degree established by Sumner Welles, is another. One does not have to be very familiar with international politics and relations to realize that a united Western Hemisphere is one of the greatest conceivable guarantees of a durable peace. Unfortunately we have learned during the past years that differences in race, temperament and economic interests make a united Western Hemisphere—which, at no time, seemed too Utopian—not so easy to accomplish.

Here the biologist meets opportunities such as he has never, if ever, met before. Agriculture, biology and medicine are fields in which Inter-American co-operation has an opportunity to do things so great that no one can question their usefulness and need; moreover, they are things which have a very strong bearing upon Inter-American economic and political relations. Though many of us in the countries of the Western Hemisphere realize these simple facts and this dramatic opportunity thrown in our lap, not too many of us seem aroused, in spite of the support of the Government and our large foundations. Is it due to the intuitive reluctance of the man of science to get mixed up in Government projects? Among biologists all over the world there is a feeling that relations with government (I do not mean any specific political group) should be avoided whenever possible. This may be a sound attitude from the point of view of pure research; from all other points of view it is a mistake. It reveals poor ability to read the signs of the times. Who should know better than the biologist that with the development of organisms their ecology becomes more and more intricate?

The structure of human society has become so complicated that it can no longer function well without regulation. This is not a political creed; it is a fact which we can observe all over the world. The government—to use a simple colloquialism—is there to stay, and we biologists should make of this opportunity what we can. Let us hope the biologist may see his opportunity and duty, for never before has he been in such a position to influence with simple means and little, if any, sacrifice the course of development of the Western Hemisphere directly and the world at large indirectly.

Much has been written during the past years about the form, aims and scope of inter-American co-operation in the pure and applied, plant and animal sciences. I will restrict myself to a few remarks and desiderata:

(1) Co-operative studies of the flora and fauna of tropical America are necessary, and more workers must be found for this work, even if it means some discontinuance of research of the Old World tropics.

(2) Students must be exchanged on a much larger scale.

(3) The problem of a common language must be solved in some way. Very probably it will find its solution best if the Latin American men of science make an increased use of English in their scientific publications and correspondence abroad. Their North American neighbour, however, must be able to read Spanish, both to understand the publications of his Hispanic colleagues and to appreciate their culture, which differs considerably more from the North American than, for example, the British or Scandinavian.

(4) An inter-American professional biological journal, with articles and notes in the three languages, if possible backed by an inter-American biological society, seems desperately needed to establish a common meeting ground.

(5) An inter-American biological station of the Woods Hole type, somewhere in Latin America, could do much good, especially if organized by biologists and agronomists, on a truly inter-American basis. It is very sad that the Inter-American Institute of Agriculture has not been organized by representative men of science. With the same means and effort something better could have resulted. But the biologists of the Americas are also at a fault for having watched (or not having watched at all) the development of this Institute with such an utter detachment.

I have devoted much space in my *Chronica Botanica* for the past few years to the promotion of inter-American relations and will shortly issue a volume entitled "Plants and Plant Science in Latin America". A single individual, however, cannot do very much. An inter-American biological society, an inter-American biological journal, and an inter-American biological station are needed; the latter will assure us of more satisfaction than merely a pleasant scientific holiday.

The biologists of the United Nations are, or will soon find themselves, in a truly unique position.

Some of them will have the opportunity of assuming leadership in the conduct of international relations work, with its profound implications.

A group of them can be instrumental in assisting in making the Western Hemisphere strong and influential, one of the least Utopian guarantees of a durable peace.

Further, they will all be in a position to assist with the creation not of a planned supreme State, which is the criterion of all values, but of a government of free responsible men, which will guide human relations and world affairs according to the laws of living Nature, as discovered and set forth by biologists.

## CONSTITUTIONAL ISSUES IN SOUTH-EAST AFRICA

By PROF. DARYLL FORDE
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THE recent announcement by the Secretary of State for the Colonies concerning the establishment of a standing Central African Council for the three territories of Southern Rhodesia, Northern Rhodesia and Nyasaland represents a further step in the attempt to secure an orderly solution of economic problems and political issues that have been intensified by the War. These three contiguous territories, each with an African population of about one and a half millions, share in varying degrees the problems that arise from the introduction of Western technology and white settlement in Africa. The issues are, however, by no means identical in each territory, and these differences, together with a conflict between the British Government and local white sentiment over long-term native policy, present serious obstacles to satisfactory constitutional development.

Southern Rhodesia, with a European population of about 69,000, has had virtual Dominion status since 1923, and its executive government is responsible through the legislature to an electorate practically confined to whites. Although its constitution reserves to the Secretary of State for the Dominions considerable control over native affairs, this is of limited practical effect. The segregation of the native population and their exclusion from some occupations, in order to protect Europeans from native competition, are, as in South Africa, avowed objects of both the Government and the European population.

A substantial majority of the white population of about 13,000 in the Protectorate of Northern Rhodesia, most of them directly or indirectly dependent on the mining industries, share the sentiments of the white Southern Rhodesians. Despite the absence of any legal sanctions and the positive legislation of the Protectorate, they too are able, in practice, to impose restrictions on the employment and status of the native population.

In the Protectorate of Nyasaland, on the other hand, with a small white population of less than 2,000 planters, the principle of trusteeship and "the paramountcy of native interests" which is accepted by the British Government and so widely endorsed in Great Britain meets with less effective local opposition.

The whole problem is still further complicated by the fact that a very large proportion of the African male population, amounting to more than 100,000 in each of the territories, is employed as migrant labour on European farms and mines away from its native settlements. This has not only produced serious dislocation in native agriculture and community life, which is bitterly resented by champions of the African cause, but also, since there is a large-scale migration of labour across frontiers, calls for co-ordinated action in all the territories concerned.

The Southern Rhodesia Government has, over a number of years, pressed for the unification of the three territories under a responsible government which could, among other things, deal with the labour problems of the area as a whole. The evidence given to the Bledisloe Commission of 1938 revealed strong native opposition to amalgamation on which the Commission itself could not agree; but the impact of the War and the contribution of the white peoples of Africa to the defence of the Empire have sharpened the issue. The regional grouping of colonies in the interests of technical development and administrative efficiency has gained increasing support, while General Smuts, in his speech at the end of last year, claimed for the Dominions a larger share of responsibility for the colonial territories in their respective spheres—in other words, the increasing influence of South Africa in the development of the southern African territories. The Prime Minister of Southern Rhodesia, Sir Godfrey Huggins, had earlier secured an undertaking that the question of amalgamation should not necessarily be postponed until after the War; while to meet the urgent needs of production and supply during the War, the Governors' Conference of these three south-east African territories has been supplemented by a joint secretariat.

The British Government now proposes to set up a standing Central African Council with a permanent secretariat, to deal with matters of common interest to the three territories. While only consultative, it is designed to provide machinery for the permanent co-operation of the administrative and technical services of the three Governments in such fields as industry, agriculture, labour, education and medical services. It is intended, in the words of the statement, that "leading unofficials in Southern Rhodesia and Nyasaland should be closely associated with the work of the Council", and it is recognized "that the Southern Rhodesia Government still adhere to their view that the three territories should be amalgamated". Amalgamation is, however, regarded as not being practicable "in existing circumstances", which, as Colonel Stanley explained in answer to questions in the House of Commons, refers not merely to the continuance of the War but also to "the difference in African policy between the territories".

At the same time it is proposed to take a further step forward in the constitutional development of the Northern Rhodesia Protectorate by increasing the unofficial membership of the Legislative Council from one to five, of whom three will represent the interests of the African community. The statement declares that "it is intended that African interests in the Legislative Council should be represented by Africans as soon as a suitable basis of representation can be built up", and the British Government is looking to the recently established Provincial African Councils as a political nursery for this development. This announcement concerning Northern Rhodesia, together with the express limitations on the powers of the Central African Council, makes it clear that the British Government still seeks to promote the growth of an educated and politically experienced African population which shall play its part in government.

# APPLICATIONS OF D.D.T.

TYPHUS can upset the plans and frustrate the might of the most powerfully armed forces. During the War of 1914–18 it killed some 10,000 people in six months in Serbia; after the Russian Revolution it killed some three million Russians. It has been recorded that during the siege of Granada and in the Thirty Years' War and the campaigns of Napoleon, it killed more people than the military weapons then in use. A disease which frequently attacks starved and disorganized populations and flourishes in times of national disaster, it broke out in Spain in 1908 and again in 1941, and it is a constant problem in the South American States and elsewhere. It has to be watched constantly, and the pages of the *Tropical Diseases Bulletin*, the *Bulletin of War Medicine*, the *Boletin de la Oficina Sanitaria Panamericana* and other medical journals record the work that is being done on all its aspects.

Epidemic typhus is caused by *Rickettsia prowazeki* transmitted rapidly from man to man by head and body lice. It should be distinguished carefully from endemic typhus, which is transmitted from rats to man by the rat flea. The old epidemiological rule "no lice, no typhus", quoted by the *Lancet* (115, July 22, 1944) still applies to epidemic typhus, and the best method of control is to attack this link in the epidemiological chain. Until recently, the lice have been attacked by heat and fumigation, and the organization and conduct of delousing stations has been no easy task, especially when large populations have had to be deloused. These methods, moreover, do not keep a population free from re-infestation with lice, which quickly occurs. Until comparat vely recently, no insecticide was known which would keep a person free from lice for longer than two days or so. Early in this War, work was undertaken to find new insecticides. A general review of the discovery and properties of D.D.T. was contributed to *Nature* of September 16, p. 352, by Prof. J. W. Munro. The story, so far as it concerns typhus, is briefly told in the *Lancet* (115, July 22, 1944) and the *British Medical Journal* (217, August 22, 1944).

Early in the War, British scientific men produced an insecticide called AL 63, which protected persons from lice for five–six days when it was dusted on to their underwear. Organic thiocyanates sprayed on to underwear protected the wearer for a month and could also be used on a belt so devised that it attracted the lice and then killed them; but these thiocyanates caused smarting when those who used them began to sweat. When the United States entered the War, teams of workers were put on this problem, and a dust called MYL was produced (*Soap and Sanitary Chemicals*, 105, November 1942), which was recommended by the U.S. Bureau of Entomology and Plant Quarantine. Russian workers had, in the meantime, developed two synthetic compounds, a powder containing diphenylamine, which was successfully used on civilians in Moscow (Fedder, M. L., *Gigiena i Zdorov'e*, No. 10, 12; 1942; quoted by the *Lancet, loc. cit.*) and *bis*-ethyl-xanthogen, with which garments worn by Russian soldiers in Bessarabia were impregnated (Gorkina, A. N., *Med. Parasitol., Moscow*, 11, 90; 1942; quoted by the *Lancet, loc. cit.*). Then came the discovery that the synthetic compound 2,2-*bis* (parachlorphenyl) 1,1,1,-trichlorethane), which has been called D.D.T., from the generic name dichlor-diphenyl-trichlorethane, has insecticidal properties of considerable promise. D.D.T. was first synthesized by the German chemist O. Ziedler in 1874 (*Deutch. Chem. Gesell.*, 7, 1180; 1874). Its insecticidal properties were apparently first made known by Paul Müller in Switzerland, when he reported his work with it on moths, flies and plant lice. In 1940 the Swiss firm of Geigy and Co., of Basle, patented it. Preparations of it are available under the name "Gesarol", either as a spray containing 5 per cent of D.D.T. with a wetting agent, or a dust containing 3 per cent of D.D.T.; another dust, called "Neocid", containing 5 per cent D.D.T. was produced for treating human lice.

Methods of manufacture were quickly improved and the toxicity of D.D.T. to a large number of insect pests, as well as to human lice, has been tested. An account of this work has been given by P. N. Annand and his co-workers (*J. Econ. Entom.*, 125, 37, February 1944), and the earlier work done with D.D.T. in Switzerland and Germany is there noted.

Annand concludes that D.D.T. is "one of the more promising synthetic organics" for the control of insects—a sober statement which should be borne in mind in these days when publicity is apt to exalt new discoveries far beyond the claims made for them by scientific workers. A reaction of some insects suggests, Annand says, that it acts as a nerve poison. It is distinctly toxic when it is dissolved in solvents such as oil, which can penetrate the skin, or when it is ingested; and more work is needed on its toxicity to man and animals. Appropriate precautions should therefore be taken by personnel who employ it as a dust likely to be inhaled or swallowed or in oily solvents. But in the concentrations in which it has been used for the control of human lice, it is apparently safe if reasonable precautions are taken: in these concentrations it does not appear to irritate the human skin.

D.D.T. is a crystalline solid, practically colourless and practically odourless, which results from the interaction of anhydrous chloral and chlorobenzene in the presence of concentrated sulphuric acid. It is insoluble in water, but soluble in most organic solvents. It is 'rather stable' and its volatility is low, so that loss of it from spray deposits is too slow to decrease its activity appreciably.

The tests of its action on human body and head lice and also on the human crab louse recorded by P. N. Annand (*loc. cit.*) indicate that it is highly effective and that its action lasts longer than that of any other louse treatment. It is better than MYL. It can be used as a powder diluted with kaolin or pyrophyllite, and such powders will protect grossly infested persons against lice for two to three weeks and will give effective control of lice for longer periods. It is equally effective against head or crab lice. The powder can be blown up the sleeves or down the necks of dressed persons, and this was done in controlling the outbreak of typhus earlier this year at Naples. The method is quick and has enabled the Naples authorities to treat a maximum number of 73,000 persons in a single day—a feat which could not be equalled by any other method. Another way of using it is to impregnate undergarments with it by dipping them in a solution containing D.D.T. in volatile solvents or in aqueous emulsions containing it. Both methods are good for either cotton or woollen garments. It is claimed that such garments will protect their wearers for three to five weeks without washing. Garments washed once a week protect for two to three weeks, or with stronger solutions for five to six weekly washes. Even stronger solutions will

protect for nine weekly washings. For the troops, a solution rendering garments protective for six to eight weekly washings has been recommended, and arrangements for large-scale treatment of such garments have been made.

Apart from its value for the control of typhus, D.D.T. may prove valuable for the control of a wide variety of insect pests. Annand and his co-workers (*loc. cit.*) report the results of their tests of its action on the bedbug, the house- and stable-fly, ticks and fleas of dogs, goat lice, "German" cockroaches (*Blattella germanica*), ants and termites, larvæ of the house-fly and numerous plant pests. For the control of the larvæ of malaria-carrying mosquitoes it is being tried as an emulsion sprayed over waters containing them, and the method of spraying it from the air is also being tried in an attempt to kill mosquitoes infected with malaria in areas in which troops have to operate. For the control of some species of cockroach it certainly seems to be effective. Recently an appeal reached the writer from a Manchester hospital for some means of exterminating a pest of 'steamflies' (*Blattella germanica*) on the hospital premises; Dr. H. Hurst sent a supply of a preparation containing D.D.T. and pyrethrum, with very good results. J. M. Ginsburg records (*J. Econ. Entom., loc. cit.*) the results of his experiments on the action of D.D.T. on this species of cockroach, which is a growing and serious pest in various parts of North and South America. Ginsburg found that the minimal concentration of D.D.T. required to kill 100 per cent of these cockroaches in jars in 48 hours was 7 per cent, while 33 per cent of sodium fluoride was required to kill 100 per cent of the cockroaches under the same conditions. In the same time a dust containing 33 per cent of derris killed only 30 per cent of them, while a dust containing 33 per cent of pyrethrum killed 90 per cent. If D.D.T. is as toxic as this to *Blatella germanica*, the work now being done on its action on locusts should be interesting.

Much of the work on D.D.T. is summarized by V. H. Chambers, G. L. Hey and N. K. Smitt, of the Murphy Chemical Company, Wheathampstead, in a reprint of an article in the *Market Grower* (62 Doughty Street, W.C.1—the date of the issue of this journal containing this article is not given). These authors refer to the work with D.D.T. done in Switzerland by R. Wiesmann (*Schweitz. Z. Obst.-u. Weinbau*, **51**, 155, 206, 245 and 329; 1942) on its effect on bees and fruit and vine pests and (*Anz. Schadlingskunde*, Berlin, **19**, 5; 1943) on flies in cowsheds. These authors also describe their own work with D.D.T. in the form of the Murphy Chemical Company's proprietary spray called 'DeDeTane' and with this Company's other preparations of D.D.T. Encouraging results were obtained against caterpillars of the tomato moth and against the grain weevil and the apple blossom weevil. 'DeDeTane' was, however, not so effective as nicotine against the apple sawfly, and it failed to control the plum leaf-curling aphis. Its possibilities as a means of controlling other insect pests are discussed, and the American work is summarized. D.D.T. may, according to this article, partly replace pyrethrum in the aerosol 'bombs' widely used by the United States Army for the disinfestation of tents, aeroplanes, buildings, etc. (But Mr. Lyttelton has announced in Parliament that the entire output of D.D.T. is being taken for military use and that, apart from a small quantity released for use in air-raid shelters, none can be released for civilian use (*The Lancet*, 485, Oct. 7, 1944).) In a reprint from *Fruit* (W. Seabrook and Sons, Chelmsford—the date of the issue of this journal containing this article is not given) it is claimed that in a field trial of 'DeDeTane' against the apple blossom weevil, a "very large reduction of infestation was secured". It is concluded, however, that much more work is required before the efficacy of D.D.T. against this weevil can be finally assessed.

It is clear that D.D.T. will have many uses other than the control of the lice which transmit typhus. Field tests should be made on its action on such insect pests of domesticated animals as the blowfly and the lice of mammals and birds. It might even prove useful against human scabies and the scab mites of animals. But we must not expect too much of it. Local factors in the environment will always affect the action of even the best insecticide. It is one thing, for example, to kill 100 per cent of house-flies or mosquito larvæ with D.D.T. or any other substance in the laboratory, and quite another to kill these quickly on a large scale in a tropical area where they are causing the deaths or illnesses of large numbers of human beings; or to do the same thing among populations whose normal habits, or disorganization during disaster, stultify the best of sanitary plans; or to apply such a remedy to large herds and flocks of domesticated animals or to extensive crops in the spacious areas of America or Australia. All remedies of this nature are subject to this kind of limitation. We are fortunate, indeed, in having, while the War lasts, opportunities for the control of both the experimental man or animal and of their environment which should enable us to investigate these aspects of the problem more thoroughly than we could investigate them in times of peace. In this respect, our partial and, we hope, temporary, loss of freedom is a help rather than a hindrance to progress.

G. LAPAGE.

# OBITUARIES

## Mr. H. P. Marks

HENRY PERCY MARKS, a member of the scientific staff of the Medical Research Council at the National Institute for Medical Research, died on September 13 after a short illness. After serving in the Navy in the War of 1914–18, Marks joined the Medical Research Council as an attached worker at Hampstead in 1922, and was appointed a member of the staff in 1927. His work at Hampstead was mainly concerned with insulin and carbohydrate metabolism although, in collaboration with others at the Institute, he also carried out interesting work on the mechanism of action of calciferol. More recently, Marks had become interested in the influence of the pituitary gland on carbohydrate metabolism and had published a number of papers on this aspect of the subject. For the two years immediately preceding his death he had been assisting in research work of national importance in connexion with the War, and had undertaken the arduous duties involved with the enthusiasm of a man many years younger. His untimely death will be mourned by his many colleagues and friends at Hampstead and elsewhere.

Marks's most important work was concerned with the standardization of insulin and more recently with the standardization of potamine zinc insulin. He visited both Copenhagen and Toronto in this con-

nexion, and was in part responsible for the biological assays which finally fixed the activity of the international standard preparations. As the result of his work on the standardization of insulin, Marks became interested in statistical analysis in relation to biological assay, and made some important contributions to this aspect of the subject. He was also a microchemist of some standing and had visited Graz in 1925 to attend the special course in this subject which was held there.

Personally Marks was rather shy and was not so well known among his scientific colleagues as might otherwise have been the case. But those who came into contact with him at Hampstead and elsewhere were always attracted by his charm of manner, and it is no exaggeration to say that he never failed to be on good terms with all his many colleagues. The early death of 'H. P.' will leave a gap which will be difficult to fill.

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WE regret to announce the following deaths:

Dr. Alexis Carrel, known for his medical researches chiefly at the Rockefeller Institute of Medical Research, New York, aged seventy-one.

Prof. J. H. Priestley, professor of botany in the University of Leeds, on October 31, aged sixty-one.

Dr. D. S. Raitt, naturalist at the Marine Laboratory (Aberdeen) of the Scottish Home Department, on October 4.

# NEWS and VIEWS

## Royal Society: Medal Awards

THE following awards of Royal Society Medals for 1944 are announced:

Copley Medal to Sir Geoffrey Taylor, Yarrow research professor of the Royal Society, in recognition of his many contributions to aerodynamics, hydrodynamics, and the structure of metals, which have had a profound influence on the advance of physical science and its applications.

Rumford Medal to Dr. H. R. Ricardo, in recognition of his important contributions to research on the internal combustion engine, which have greatly influenced the development of the various types.

Davy Medal to Sir Robert Robertson, lately Government Chemist, in recognition of his researches on explosives, analytical methods, the internal structure of the diamond, and infra-red absorption spectra.

Darwin Medal to Prof. J. Stanley Gardiner, lately professor of zoology and comparative zoology in the University of Cambridge, in recognition of his work on coral reefs and on the organisms associated with such habitats.

Hughes Medal to Prof. G. I. Finch, professor of applied physical chemistry at the Imperial College of Science and Technology, in recognition of his fundamental contributions to the study of the structure and properties of surfaces, and for his important work on the electrical ignition of gases.

## Nobel Prize for Physiology and Medicine for 1943: Profs. H. Dam and E. A. Doisy

IT is announced that the Nobel Prize in Medicine for 1943 has been awarded jointly to Prof. Henrik Dam and Prof. E. A. Doisy for work on vitamin K. Looking back, we may recall that it is now fifteen years since the first Nobel Prize given for research on vitamins was shared by Sir Frederick Gowland Hopkins and Prof. C. Eijkman, as a tribute to their pioneer observations in this field of science. Prof. Eijkman had been concerned specifically with one vitamin factor, namely, vitamin $B_1$; and since then other Nobel Prizes have been awarded at various times for researches on vitamins A, C and certain components of the B complex. It is fitting that the latest prize should mark the completion of an important chapter in nutritional knowledge, namely, that concerned with vitamin K, for it is one of the vitamins, still relatively few, which have so far been proved to have important clinical uses.

It was in 1929 that Dam, working at Copenhagen, recorded hæmorrhages which occurred in chicks raised on synthetic diets poor in certain fat-soluble vitamins. In 1934 Dam and Schønheyder concluded that this disorder was due to deficiency of some new vitamin which they not inappropriately called vitamin K ("Koagulations Vitamin"). Soon afterwards they published their fundamental finding regarding the mode of action of vitamin K, namely, that it is concerned in maintaining the normal value of the prothrombin in the blood. In the course of the next year or so, several groups of workers, including Dam, demonstrated the clinical usefulness of vitamin K. It finds its application in two main directions, namely, in preventing the hæmorrhagic disease of new-born babies, and in controlling hæmorrhages after the surgical treatment of obstructive jaundice, a condition which had often proved fatal in the past. The routine method commonly used for assessing the effectiveness of vitamin K therapy, or detecting the presence of a deficiency, is based on Dam's work, namely, a determination of the level of prothrombin in the blood. Dam, who published his earlier investigations from Copenhagen, has been living in the United States of America since 1940.

The two most important forms of vitamin K occurring naturally are those known as vitamins $K_1$ and $K_2$. Like all vitamin-K active substances, they are both naphthoquinone derivatives, and both have been synthesized in recent years. Numerous active synthetic analogues are also known, and now largely replace natural $K_1$ or $K_2$ in treatment. The isolation of pure vitamin $K_1$ was reported in 1939 by Dam in collaboration with Prof. Karrer and their several co-workers; and almost simultaneously Doisy and his colleagues of the University of St. Louis isolated $K_2$. In the very same year three laboratories independently achieved the synthesis of vitamin $K_1$, namely those of Doisy, of Almquist and of Fieser. The demonstration of the vitamin activity of the relatively simple compound, 2-methyl-1,4-naphthoquinone, which can be regarded as the prototype of the K vitamins, was due to Ansbacher and Fernholz. In the following year Doisy with his collaborators crowned their chemical studies of the K group by elucidating the structure of vitamin $K_2$.

## Chair of Natural Philosophy at St. Andrews: Prof. H. Stanley Allen, F.R.S.

PROF. H. STANLEY ALLEN has retired from the chair of natural philosophy in the University of St. Andrews. His life in St. Andrews has been one of quiet painstaking work characterized by thoroughness in everything he undertook. His highest quality was a constant striving for the clearest, the best, way in which he could present a point. A simple example is his treatment of entropy. He has stated that in his opinion it is necessary that the beginner in a scientific subject should be given at the outset some familiar mental picture. He then points out that momentum is a vector quantity depending on the first power of the velocity, and remarks that therefore it is not likely to be a suitable analogy for entropy. It has to be remembered that Kelvin's definition of entropy makes it vary directly with the heat and inversely with the temperature. He then points out that on the basis of the kinetic theory of gases, not only the square of the velocity is involved, but also the time taken by one molecule to pass over the space in the near neighbourhood of any other. He finally shows that Callendar's identification of the energy with the form $\frac{1}{2}QV^2$ gives agreement. Prof. Allen has spent twenty years of his life in St. Andrews, and the sympathy of everyone who knows him will go out to him in his recent great loss through the death of his wife. All will entertain the hope that the greater freedom from routine labour consequent on his retirement may enable him to devote more time directly to the service of the science in which he takes his delight.

## Prof. J. T. Randall

DR. J. T. RANDALL has been appointed to the chair of natural philosophy in the United College, St. Andrews, in succession to Prof. H. Stanley Allen. Dr. Randall was educated at the Victoria University of Manchester under Prof. W. L. Bragg, and before joining the staff of the Research Laboratories of the General Electric Company, Ltd., Wembley, carried out research work on the scattering powers of atoms for X-rays. In 1937 he was elected a Royal Society Warren research fellow, and joined Prof. M. L. E. Oliphant in the University of Birmingham, where an intensive study of the mechanism of luminescence in solids was carried out. Publication of much of this work has been delayed for security reasons. At the outbreak of war Dr. Randall turned his attention to problems associated with radiolocation, and succeeded with Dr. H. A. H. Boot in introducing a new type of apparatus which has resulted in the saving of many lives at sea. For this work Dr. Randall and Dr. Boot were recently awarded the Thomas Gray Memorial Prize of the Royal Society of Arts. Since 1943 Dr. Randall has been a temporary lecturer in the Cavendish Laboratory, Cambridge.

## Prof. William Wilson, F.R.S.

PROF. WILLIAM WILSON, who has recently retired from the Hildred Carlile chair of physics at Bedford College, University of London, spent his student days at the Universities of London and Leipzig, and he found much to admire in the freedom of the German university system of those days and in the men who sustained it. In his early years as a physicist, he carried out much pioneer experimental work on photo-electric emission and developed a quantum theory of thermionic emission, which was published in 1912. By 1915 he had discovered the qu relation $\int p.dq = n.h$, and by introducing quantum numbers, he found an expression 1 eccentricities of the elliptic orbits of electrons he opened up a large field of progress in the of atomic structure. In 1921 he introduced th cept of generalized momentum into the theory electromagnetic field, and has since become interested in Kaluza's five-dimensional theo relativity. He was elected a fellow of the Society in 1923.

It is only possible to mention a few of Prof. W many contributions to physics; he is more fa than many scientific men with the work of phy and mathematicians of the past, and his own has in consequence a rare maturity and under ing. He thinks in an original way about a fundamental principles of physics. Beside writings in scientific journals, he completed i the third volume of a work on "Theoretical Ph which is the culmination of his lectures to adv students. It is a unifying account of many a of the subject and has great elegance of style. Wilson has always delighted to share his kno and wisdom with others and this makes him a teacher. Besides his o ..cial pupils, many colleagues and fellow workers have sough obtained help and instruction from him. H served the University of London in many capa including that of senator, member of the Ex Council and chairman of the Board of Stud Physics.

## Structure of the Kiogar Mountains

DR. E. B. BAILEY, director of the Geological S of Great Britain, gave a Friday discourse on ember 3 at the Royal Institution on "Mou that have Travelled Over Volcanoes". Many m tain chains present a complexity of internal str which recalls, with great magnification, that o ice piled sheet upon sheet by a tempest of yest In 1893 it was realized by geologists studyin Alps that a far-travelled thrust-sheet may oft distinguished by the foreign characteristics constituent geological formations, just as clearl far-travelled man by the foreign characterist his face and dress. The Kiogar mountains c borders of Tibet and India illustrate this phenon to perfection. The rock formations makin summits have very special characters spok collectively as Tibetan. The underlying form making the lower slopes are shown by their to be of the same geological age as the Ti formations overhead; but they have much familiar characters spoken of collectively as alayan. Between the Tibetan and the Hima developments lies a thick separating complex of igneous rocks. Some of these igneous rocl submarine lavas, following in normal succession the underlying Himalayan sediments. Some, ever, exhibit intrusive relations and penetrat overlying Tibetan sediments. The conclusi reached that in the days before the upheaval of local sea bottom to give the Himalayan moun an invading thrust-sheet penetrated the area the north. On its way it passed over a gro submarine volcanoes, which, driven undergr maintained a guerilla attack by injection of m material from below. Wear and tear due to drawal of over-run, overloaded mobile sedi added to the general confusion.

## Problems of the Gas Industry

ON October 24 Mr. A. E. Sylvester addressed the Fuel Luncheon Club on some immediate problems of the gas industry in Great Britain. The speaker, as managing director of the Gas Light and Coke Co., London, spoke on administrative rather than technical problems. He appealed for freedom of choice for the consumer of fuels, while recognizing the need for some sort of control to see that prices are reasonably related to cost of supply taking into account all the circumstances. The gas industry includes far too many small units, which, though possibly manufacturing gas satisfactorily, are unable to maintain the technical staffs adequate to give the service to consumers which present-day conditions require. The aggregation of the industry into larger groups would provide openings for more specialist technicians, while a national pension scheme would favour a freedom of movement which would be beneficial both to themselves and to an industry national in scope. Mr. Sylvester pleaded for sales tariffs which deal justly as between one type of consumer and another. It is sound policy to relate changes to cost as closely as circumstances permit, otherwise one article has to subsidize another. When gas is supplied to a factory, the charge must cover not only manufacture but also capital costs up to the works, and little more. For domestic fuel the charge must go further, covering the heavy costs of services to the consumer. The resultant charges must differ, otherwise justice is not done as between consumers. It was emphasized that gas is a refined fuel and is used because of the service it gives; this emphasis implying the necessity for a high standard of service throughout the country.

## A Study of Reason

PROF. H. J. PATON, in his lecture to the British Academy entitled "Can Reason be Practical?" (London: Oxford University Press, 1944. 4*s*. net), defends against recent attacks the view that moral principles are rules of reason. Some have maintained that moral judgments are merely the expression of private emotions or merely the result of pressure of the social environment, and that the attempt to justify them is 'rationalization' in the bad sense. Against these critics he argues that if they would only apply their theories to their own judgments they would see their absurdity. Those who oppose instinct or intuition to reason are making a false antithesis. The infant sucks by instinct, but ought to realize later that it was the most reasonable thing to do in the circumstances. Prof. Paton develops the positive side of his argument from the starting point that human conduct should at least be intelligent, that is to say, consistent and orderly, so that means are adapted to ends and conflicting impulses subordinated. The principles of practical reason are the result of taking this notion of order and consistency as far as it will go and generalizing as completely as possible. The rest of Prof. Paton's exposition is on Kantian lines, but with some useful clarification and, perhaps, some modification in the direction of what Kant ought to have said.

## Collaboration with French Men of Science

THE executive committee of the Association of Scientific Workers has sent a message of greeting to French men of science who have taken part in the Resistance Movement in France. "It looks forward to close collaboration between the scientific workers of both our countries for the progress of our common aims: the development of science and its use to advance the living and cultural standards of all peoples". The Association des Travailleurs Scientifiques, formed from the Resistance Movement a few days after the liberation of France, has acknowledged this greeting conveyed through Prof. Joliot-Curie. "In its refusal to accept the defeat of France as final and to submit to the subsequent German domination, the Resistance movement has, since 1940, been animated by that same spirit which inspired the entire British nation when it decided to continue the struggle. This community of ideas concerning the conduct of the war must continue in the maintenance of peace. The great contribution made by science to the national defence can be continued in the economic and social spheres of the peace-time world organization of to-morrow."

## Announcements

SIR HAROLD HARTLEY will deliver the Lavoisier Bicentenary Lecture of the Royal Society on November 16, at 4.30 p.m.

THE Club for Research on Ageing (c/o Department of Zoology and Comparative Anatomy, University, Oxford) has received from Lord Nuffield a donation of £3,000, which will enable Dr. V. Korenchevsky to continue his gerontological investigations for a period of three years. Clinical trials of the effects of vitamins on aged persons at the Tooting Bec Hospital will be finished at the end of the year. These were rendered possible during the last two years by substantial grants from Lord Nuffield and the Nuffield Foundation. The Club expresses its heartfelt thanks for these benefactions and is also very much indebted to the London County Council for most valuable co-operation.

THE Trustees of the Miners' Welfare National Scholarship Scheme invite applications for a limited number of university scholarships and exhibitions. Candidates must be either workers in or about coal mines in Great Britain, or sons or daughters of such workers, and normally should not be less than seventeen years of age on January 25. Forms of application and full particulars may be obtained from the Secretary, Miners' Welfare National Scholarship Scheme, Ashley Court, Ashtead, Surrey. Applicants for forms must state whether they apply as workers in or about mines or as children of such workers; those who come within both categories should apply as workers. Completed applications must be received by January 25.

THE Council of the Institution of Civil Engineers has set up a special War Service Committee to deal with the cases of prospective candidates for election whose engineering training has been interrupted by the War, with a view to these candidates being advised in regard to the periods of practical training and/or engineering experience and the examination qualifications they will be required to obtain before the Council will consider them qualified for election to corporate membership of the Institution. Intending candidates for election who are serving in H.M. Forces, or who have been directed into work of national service, and who were less than thirty-one years of age on November 1, should apply to the secretary for particulars.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Crystal Structure of Coronene

THE structure of the coronene molecule, $C_{24}H_{12}$, is of particular interest in view of its peculiarly high symmetry (Fig. 1). With regard to electron distribution and bond-lengths, the structure should be somewhat intermediate between benzene and graphite. The optical and magnetic anisotropies of the molecule should also be of interest, and as a first stage in the accurate study of all these properties it is necessary to make a precise determination of the crystal structure.

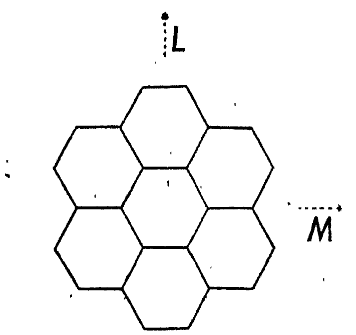


FIG. 1.

Some difficulty was experienced in growing good single crystals of the substance, but suitable specimens were finally obtained from a solution in tetrahydronaphthalene. The lath- or needle-shaped monoclinic crystals were greatly elongated along the $b$-axis, and in the best specimens the (001), (100), (10$\bar{1}$) and (20$\bar{1}$) faces were developed, the (001) usually being the most prominent. X-ray examination gave the unit cell dimensions as $a = 16{\cdot}10$ A., $b = 4{\cdot}695$ A., $c = 10{\cdot}15$ A., $\beta = 110{\cdot}8°$. The $(h0l)$ reflexions are absent when $h$ is odd, and the $(0k0)$ when $k$ is odd. The space group is therefore $C^5_{2h}$ $(P2_1/a)$. There are two centrosymmetrical molecules of $C_{24}H_{12}$ in the unit cell. (Density, measured 1·377, calc. 1·387.)

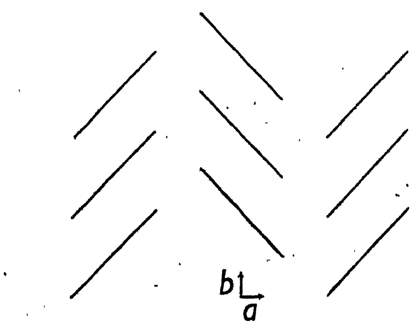


FIG. 2.

The crystal habit and especially the very short $b$ axis are similar to those of the phthalocyanines[1], and this suggested that these large flat molecules might be similarly arranged in the crystal. Detailed analysis has now shown this to be the case. The plane of the coronene molecule is inclined at approximately 45° to the $b$ crystal axis, an end view of the arrangement being roughly as shown in Fig. 2. The perpendicular distance between the molecular planes is between 3·3 and 3·4 A., just a little less than the interplanar spacing in graphite (3·41 A.).

The orientation of the coronene molecules in the crystal can be stated more precisely with reference to the molecular axes $L$ and $M$ (Fig. 1) and their normal, $N$. If $\chi_L, \psi_L, \omega_L$; $\chi_M, \psi_M, \omega_M$; and $\chi_N, \psi_N, \omega_N$, are the angles which these molecular axes make with the $a$ and $b$ crystal axes and their perpendicular, then we find

$$\begin{array}{lll} \chi_L = 85{\cdot}0° & \chi_M = 45{\cdot}3° & \chi_N = 134{\cdot}9° \\ \psi_L = 85{\cdot}1° & \psi_M = 45{\cdot}5° & \psi_N = 44{\cdot}9° \\ \omega_L = 7{\cdot}0° & \omega_M = 97{\cdot}0° & \omega_N = 89{\cdot}9° \end{array}$$

The figures are probably accurate to within 1–2°.

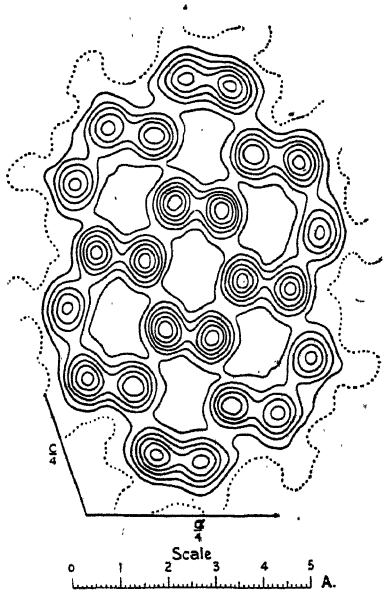


FIG. 3.

The structure is such that it is possible to compute an accurate two-dimensional projection of the electron density distribution on the (010) plane (that is, along the direction of the $b$ crystal axis) by the method of double Fourier series. The result of this calculation is shown in Fig. 3, where each line represents a density increment of approximately one electron per A.$^2$ (the one-electron line is dotted). It will be noted that every carbon atom in the molecule is very clearly resolved, and with further refinement of the measurements and calculations it should be possible to make very accurate determinations of the interatomic distances. When allowance is made for the 45° inclination of the molecular plane to the plane of the projection (010), it is found that the hexagons are regular, and already there are indications that the average C—C distance is slightly greater than the accepted value for benzene (1·39 A.). This distance is probably nearer to the graphite value of 1·42 A., but more accurate measurements and the inclusion of higher order terms are necessary before this can be definitely established. The Fourier series used for the calculation of Fig. 3 contained about eighty terms.

We are indebted to Mr. E. J. Bowen and to Messrs. Imperial Chemical Industries, Ltd., for specimens of the hydrocarbon coronene.

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[1] Robertson, J. M., *J. Chem. Soc.*, 615 (1935).

## Crystal Structure of β-Aluminium-Magnesium Alloy

A PIECE of β-aluminium-magnesium alloy of irregular shape, when examined by the Laue method, showed all the characteristics of the Laue symmetry $m3m = O_h$, which proves conclusively that β Al-Mg is cubic and not hexagonal as assumed by K. Riederer[1]. By means of rotation photograms the length of the edge of the unit cube was determined to be $a = 28 \cdot 13$ A. and the period of identity along a face diagonal $d = 19 \cdot 93$ A., showing that the space-lattice is face-centred. Weissenberg patterns around [100] and [110] showed that the characteristic space-group of β Al-Mg is $Fd3m = O_h^7$.

The unit cube of β Al-Mg is consequently the largest unit cell hitherto met with with alloys. With $19 \cdot 04$ A.$^3$ as volume per atom, the number of atoms per unit cube is found to be 1172, and is thus comparable with the numbers of atoms in crystals of complicated organic compounds.

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[1] *Z. Metallkunde*, **28**, 312 (1936).

## Pulsation and White Dwarfs

THE pulsation phenomenon has so far been observed only in 'super-giant' stars. However, there seems to be no theoretical reason why the phenomenon should not occur in denser stars and even in white dwarfs which are composed of *degenerate* matter. It is interesting to recall that according to current views a nova outburst is associated with a sudden collapse of the star, which after the disturbance settles down as a white dwarf. It is very likely that after such a cataclysmic disturbance the star would be left pulsating. Even if the physical conditions be not favourable for the maintenance of pulsation, yet the pulsation once started should last for a period comparable to $10^3$ years. For a white dwarf the period of pulsation corresponding to the fundamental mode is easily estimated. Assuming the 'homogeneous model', the period $P$ is given by

$$P = \left\{ \frac{9h^3}{16\pi\, m^{3/2}\, H^{5/2}\, G^2} \right\} \frac{1}{\mu^{5/2} M} \sim 10 \frac{\odot}{M} \text{ sec.},$$

where $M$ is the mass of the white dwarf, $h$ is Planck's constant, $m$ the electron mass, $H$ the proton mass, $G$ the gravitational constant, $\mu$ the mean molecular weight and $\odot$ the solar mass. In deriving the expression for the period, the effect of relativistic mechanics has been ignored. For the Stoner–Chandrasekhar critical mass the period tends to zero. The pulsation-period for a white dwarf is too small to be directly observable, and therefore the existence of pulsation in white dwarfs has to be looked for through its secondary effects.

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## Thermogenic Properties of High-Frequency Currents

IN view of the interest now being taken in high-frequency heating, as a logical development of medical diathermy, successful experiments have been made in the rapid production of crustless bread, cakes and light pastries. This technique is particularly suitable for the last two named purposes. The power used was 650 watts, and the frequency $50 \times 10^6$ c.p.s. Owing to the War, further developments have not been possible.

It may be mentioned that successful experiments were made also in heating through rapidly, and in promoting the plastic flow of, kaolin ('Antiphlogistine') poultices. Our experiments indicated that this preparation is of a polar nature. It has a loss factor of about $0 \cdot 118$. The dielectric constant is also of high value, but this has yet to be determined.

If placed in a suitable non-metallic container, short-wave diathermy equipment may be used as a source of high-frequency current for this and many other applications of diathermy technique to medical preparations which require heating. This offers the advantage of uniform and rapid heating throughout, with a considerable saving in time.

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## Tsetse Hybrids

IN 1936 I attempted to cross various species of tsetse (*Glossina*) with the idea that, should they hybridize readily, and should the resultant hybrids prove sterile, this might be tried as a measure of control. Corson had already, in 1932, obtained three offspring from crosses between male *G. swynnertoni* and female *G. morsitans*; he suggested, however, that these might not be true hybrids, but the result of parthenogenesis (see further details in the accompanying communication by Mr. F. L. Vanderplank). I obtained a number of offspring from this and other crosses, but as a slight doubt arose as to whether they were authentic hybrids, the results were never published.

The doubts arose because the females used had not come from pupæ kept isolated in single tubes, but from collections of pupæ from which the emergent imagines were cleared three times a day except during the week-end, when forty-four hours elapsed between the last clearing of the jars at midday on Saturday and their first clearance on Monday at 8 a.m. Females were therefore left for varying periods up to forty-four hours in contact with freshly emerged males of their own species before isolation for crossing. Though the work of Mellanby[1] rendered it very unlikely that females in such circumstances could become inseminated by their own species, a doubt did remain. Since then I have kept females similarly obtained without subsequent access to males, and none of them has shown any signs of fertility though they lived twenty-one days or more, sufficient to allow them to produce at least one larva; eighty females were dissected and none was found to have been inseminated. Mr. Vanderplank and I have both found that the external characters of *swynnertoni* are completely dominant in the offspring of these crosses, and the production of a *swynnertoni*-like fly by a *morsitans* female is conclusive evidence that a true hybrid has been obtained; recent exam-

ination of the genitalia of the male 'hybrids' has shown them to differ from those of both parents. Since also recent experiments by my colleague, Mr. F. L. Vanderplank (see accompanying communication), using females obtained from pupæ kept singly in tubes, have resulted in the production of similar offspring, an account of my earlier results is perhaps desirable.

Of twenty-eight female *G. swynnertoni*, paired with male *G. morsitans* and surviving twenty-one days or more, three (10·7 per cent) produced seven pupæ (2, 4 and 1 respectively) of which one was accidentally destroyed, one failed to emerge, and five produced imagines—2 ♂♂ and 2 ♀♀ and one the sex of which was not determined before it escaped. All these resembled the female parent in appearance and so might not have been true hybrids. But of forty female *G. morsitans* paired with male *G. swynnertoni*, three (7·5 per cent) produced five pupæ (2, 1 and 2 respectively), all of which produced imagines (2 ♂♂ and 3 ♀♀). This time all the offspring resembled the male parent and so must have been hybrids; as already remarked, the external characters of *swynnertoni* are dominant. I propose for the sake of brevity to call the results of the ♂ *swynnertoni* × ♀ *morsitans* cross '*swynnertans*' and of the reverse cross '*morsitoni*'.

Using the hybrids described above, two '*morsitoni*' females were crossed with male *swynnertoni* and *morsitans* respectively, and each produced pupæ, four apiece. Again, two '*swynnertans*' females crossed with ♂ *swynnertoni* produced five pupæ (3 and 2 respectively), but a third, crossed with a ♂ '*morsitoni*', failed to produce. Of these thirteen pupæ seven produced imagines, of which five were females, one was a male and one escaped before its sex could be determined. Of the five females two were crossed with pure-bred ♂ *swynnertoni* and *morsitans* respectively, two with '*morsitoni*' ♂♂, and the fifth with the one second generation male hybrid. None produced any offspring.

A series of controls (*morsitans* × *morsitans* and *swynnertoni* × *swynnertoni*) was kept simultaneously and under similar conditions (in single tubes, the pair generally remaining together until the male died). These continued to a fourth generation, which was still producing pupæ when the observations ceased.

My observations, the results of which are summarized above, and a fuller account of which is in preparation, seemed to show that the inter-specific couplings were undertaken with greater reluctance than the intra-specific ones, so that this, combined with the very scanty production of hybrids, and the fertility of the first generation of the hybrids, led to an abandonment of this line of investigation as a possible means for the control of tsetse, which seemed to me to depend on ready cross-mating and on free production of sterile hybrids. The more recent work of Mr. Vanderplank has, however, led to a reconsideration of the project, for he has shown that the two species mate freely, and are also likely to do so under natural conditions; his results have also suggested that I was lucky in the reproduction by my hybrids, for he has not, so far, obtained any pupæ from such hybrids as he has worked with. He has further pointed out that the poor production of first generation hybrids is itself a very possible means of control since it means that, where the introduced species can be released in numbers greatly exceeding those of the indigenous species, a large number of the indigenous females will be rendered sterile.

Briefly, the proposed measure of control involves the introduction of large numbers of pupæ of the alien species into country in which the infestation by the indigenous species is naturally low or artificially reduced. The hope is that the indigenous species will be sterilized and exterminated; and that thereafter, when introductions of the alien species are discontinued, it also will eventually die out, because the environment is not of a type suited to its permanent survival.

Other experiments were carried out with the above two species and *G. pallidipes*, *G. palpalis* and *G. austeni*, in various combinations, but though in each case evidence of the insemination of females by the alien males was obtained, no pupæ were produced; the numbers used, however, were too small to allow the possibility of success in these further crosses to be completely denied.

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Aug. 21.

[1] Mellanby, H., *Proc. Roy. Ent. Soc.*, A, **12**, 1 (1937); *Parasitology*, **29**, 131 (1937).

## Hybridization between Glossina Species and Suggested New Method for Control of Certain Species of Tsetse

Corson[1] and Potts[2] record crossing *Glossina swynnertoni* Aust. with *G. morsitans* Westwood. Corson crossed twelve female *G. morsitans* with male *G. swynnertoni*, of which only two females produced a total of three pupæ. All his females lived long enough for reproduction to take place. He records the offspring, all females, as being identical with pure-bred *G. morsitans*, and suggested parthenogenesis. Potts crossed both male *G. morsitans* with female *G. swynnertoni* and male *G. swynnertoni* with female *G. morsitans* (see accompanying communication by Mr. W. H. Potts).

I have recently re-investigated the hybridization of these species to test whether this might not result in sufficient interference with breeding to allow it to be used as a control measure.

All the females used in the experiments were obtained from pupæ kept singly in tubes or were isolated immediately on emergence from collections of pupæ; the females were kept individually in tubes and carefully fed; at death each female was dissected. The results are summarized in the accompanying table.

The *swynnertoni* females emerged from pupæ collected in the Shinyanga area where *G. pallidipes* were also present, but not *G. morsitans*, and the *morsitans* females were from pupæ collected in a pure *morsitans* belt at Kondoa Irangi.

The table shows: (1) that insemination of the females in inter-specific crosses took place as readily as in the intra-specific when no choice was offered, and (2) that inter-specific crosses were far less successful in producing pupæ in spite of the fact that the average life of these females was not appreciably different from that of the intra-specific controls.

*G. pallidipes* males and females were very reluctant to mate with either *G. morsitans* or *G. swynnertoni* and only could be mated in special circumstances. No successful mating took place between female *G. pallidipes* and the other species; one male *G.*

| Nature of cross ♂ | Percentage of ♀♀ inseminated | Percentage of inseminated ♀♀ living over 21 days which produced pupæ | No. of pupæ produced per inseminated ♀ living over 21 days | Average life of ♀♀ in days |
|---|---|---|---|---|
| *G. morsitans*♂♂ Expt. X *G. swynnertoni*♀♀ | 92% (37) | 10% (31) | 0·1 (3) | 70 (40) |
| *G. swynnertoni*♂♂ Control X *G. swynnertoni*♀♀ | 80% (12) | 100% (7) | 2·4 (17) | 61 (12) |
| *G. swynnertoni*♂♂ Expt. X *G. morsitans*♀♀ | 96% (45) | 24% (33) | 0·4 (13) | 68 (47) |
| *G. morsitans*♂♂ Control *G. morsitans*♀♀ | 76% (19) | 100% (10) | 4·0 (40) | 75 (19) |

N.B.—The numbers in brackets give the totals on which the percentages or averages are based; these are not the same throughout the table, as some females, counted as inseminated on the evidence of dissection, did not live long enough to produce pupæ, and also some of the females which were used to give the average life were not dissected to show insemination.

*pallidipes* mated with but failed to inseminate a female *G. morsitans*, and four male *G. pallidipes* mated with and inseminated four female *G. swynnertoni*, none of which had offspring.

The numbers of tsetse in these experiments were limited by the amount of work involved in their maintenance; to feed these adequately took six African assistants full time daily, including Sundays. The longevities of the various batches are not significantly different from each other by Student's *t* test, nor are the percentages of each group, inseminated or not, significantly different by the $\chi_c$ test, but the number of inter-specifically mated females that produced and numbers of pupæ produced by them are significantly smaller than their controls ($\chi_c$ test).

Other experiments, in which equal numbers of male and female *G. swynnertoni*, *G. morsitans* and *G. pallidipes* were mixed in a cage 30 × 30 × 30 cm., showed that mating between *G. swynnertoni* and *G. morsitans* not only occurred as readily as between the opposite sexes of the same species when no choice was offered, but also took place at random, but *G. pallidipes* did not mate with either, nor did any of the male *G. swynnertoni* or *G. morsitans* mate with *G. pallidipes*. A field experiment releasing 600 *G. morsitans* from pupæ in a *G. swynnertoni* area by Dr. C. H. N. Jackson, of this Department, showed similar results to those obtained in the laboratory. The recaptured females were kept alive, and the male genitalia of the offspring were examined.

The male hybrids have distinct genitalia and show affinities to the female parent. All the hybrids were similar to *G. swynnertoni* in external markings, contrary to Corson's observations. Both types of male and female hybrids have been crossed with each other and with pure-bred male and female *G. swynnertoni* and *G. morsitans*. The male hybrids inseminate the females, both hybrid and pure-bred, but none has reproduced or showed signs of successful fertilization. So far attempts to cross female hybrids with pure-bred males of both species have failed. Though the hybrid females were laboratory-produced flies, they lived even longer than their female parents, averaging 106·0 days.

Experiments have also shown that a few hours after a female is inseminated she is no longer attractive to males and will not permit further coitus.

Work is being continued with other species and pupæ of the same species collected in other areas. A field-scale experiment to exterminate *G. swynnertoni* by releasing large numbers of *G. morsitans* has been begun in an isolated block of scanty *G. swynnertoni* country. It appears likely that *G. morsitans* would be unable to survive permanently in the area.

It is hoped to publish full details of this work shortly elsewhere. I am indebted to Mr. W. H. Potts and Dr. C. H. N. Jackson for their help and co-operation in this work, and to Mr. S. Napier Bax, the acting director, for permission to publish this.

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Aug. 21.

[1] Corson, J. F., *J. Trop. Med. and Hyg.* (April 1932).
[2] Potts, *Bull. Ent. Res.*, 28, 129 (1937), and unpublished data.

## Fertilization of *A. maculipennis* var. *labranchiae* in the Laboratory

*A. maculipennis* var. *labranchiæ* is reported to swarm readily in a small cage (1 m. high and 50 cm. wide) if a blue light of intensity about 3 f.c. at a distance of 30 cm. is placed on top of the cage[1]. No record is known of laboratory mating of this variety without these experimental conditions.

*A. maculipennis* var. *labranchiæ* was reared in the laboratory from eggs, and the adults allowed to emerge in a cage of wire mesh, dimensions 47 cm. × 47 cm. × 60 cm. The cage was situated approximately 5 metres from the window of the laboratory, and the end nearest the window covered with a damp cloth. Under these conditions *labranchiæ* fed readily at any hour of the day on an arm introduced into the cage. After a period of ten days, viable eggs were laid in bowls of tap-water in the cage, although no artificial light of any kind was provided. Swarming was not observed.

The experiments are continuing.

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C/o D.D.M.S.,
A.F.H.Q., C.M.F.

[1] Bates, M., and Hackett, L. W., Verhand. VII Internat. Kong. Ent., 3, 1555 (1938).

## Relation of 'Folic Acid' to the Nutritional Requirements of the Mosquito Larva

IN our investigations on the nutritional requirements of the larva of *Aedes ægypti*, our procedure has been based on the methods employed by Trager[1]. Various modifications have been introduced which make for increased accuracy of observation and clearer interpretation of the results. Thus larger groups of larvæ were used, each larva being placed in a separate tube and its stage of development noted every morning and evening. All liquid media were sterilized by Seitz filtration and the contents of the tubes tested for sterility at the conclusion of each experiment.

In media capable of supporting growth, we have constantly noted that the length of time taken to reach the second, third and fourth larval instars, as well as the pupa, depends directly on the degree of adequacy of the medium. On this also depends the proportion of larvæ surviving. By suitable choice of media it is possible to interrupt larval development

at any stage, the larvæ dying in that stage, often only after many weeks have elapsed. In the wide variety of media we have used, the time taken for the change from pupa to adult has proved to be independent of the diet. In sixty experiments involving more than a thousand pupæ, this period ranged from two to three days (mean $2 \cdot 4 \pm 0 \cdot 46$ days). Ninety-seven per cent of these pupæ emerged as adults, indicating that as a rule emergence also is unaffected by the medium.

As originally reported by Trager[1], a medium comprising autoclaved yeast and liver extract is adequate for normal growth of mosquito larvæ. We have found it possible to bring to maturity 65–95 per cent of larvæ in groups grown in a sterile medium of autoclaved brewer's yeast suspended in 0·01 *M* solution of calcium chloride. A number of simple treatments have an adverse effect on the growth-promoting properties of autoclaved yeast. Thus prolonged autoclaving, and the storage of autoclaved yeast for a long period, both lead to reduced survival of the larvæ and an extended time for the change from one stage of development to the next. With dried brewer's yeast variable results were obtained; they appeared to depend on the conditions of drying and the period of storage of the dried material. On autolysing fresh brewer's yeast it was found that neither the autolysate, nor the residue, nor a combination of both was capable of promoting the same rate of growth and survival as the whole yeast had done. The autolysate and residue could not be made equivalent to the original yeast by the addition of any one of, or of all, the following substances: thiamin, riboflavin, pyridoxin, calcium pantothenate, nicotinic and *p*-aminobenzoic acids, biotin, *i*-inositol, choline and glutathione. The desired effect could, however, be brought about by the inclusion of liver extract (Armour) in the medium.

An insoluble yeast residue was prepared by exhaustive extraction of fresh brewer's yeast with boiling water. The autoclaved residue was used in conjunction with a large number of media containing some or all of the compounds listed above. The media also contained glucose, salt mixture and yeast nucleic acid. They were adjusted to *p*H 5·8. In the absence of added thiamin, riboflavin, pyridoxin, pantothenate or nicotinic acid, little or no growth occurred. On the other hand, the addition of the following substances had no apparent effect on the growth of the larvæ: biotin, inositol, *p*-aminobenzoic acid, choline and glutathione. Microbiological assay, using *Lactobacillus casei*, revealed the presence of bound biotin in the yeast residue, and the inclusion of avidin in the medium so clearly inhibited growth as to leave little doubt that biotin is an essential growth-factor for mosquito larvæ. Choline and glutathione could not be detected in the yeast residue; it seems that these compounds are not essential nutritional factors for mosquito larvæ, as claimed by Trager[2].

In all these experiments, one especially significant fact emerged: although the media employed were capable of supporting good growth to the fourth instar, *pupation did not occur*. The active, fully grown larvæ died in the fourth instar, usually after surviving for periods up to six weeks. In many instances, too, they were incapable of completely disengaging their third instar pelts, and died with the pelts still attached. Although the chitinous portions of the head and siphon were normally pigmented, the bodies of the larvæ were entirely free from pigment. The regularity with which failure to pupate was observed under these conditions is indicated by the fact that in thirty-five experiments using insoluble yeast residue and involving a total of more than seven hundred larvæ, of which two thirds reached the fourth instar, only 1·3 per cent were transformed into pupæ. It was obvious, therefore, that at least one water-soluble, heat-labile factor was still missing from our media.

Investigations on the effect of adding various other compounds, such as vitamins, amino-acids, purine and pyrimidine bases to the above media, have brought to light only three preparations capable of bringing about pupation. They are: a concentrate of vitamin $B_c$, the chick anti-anæmia factor, prepared from liver according to the directions of O'Dell and Hogan[3]; a concentrate of the ammonium salt of folic acid of potency 5,000, kindly supplied by Prof. R. J. Williams; the 'Norite eluate factor' of Peterson[4], kindly supplied by Lederle Laboratories.

These concentrates have been found to exercise a four-fold effect: (1) they induce pupation with striking regularity; (2) they improve the rate of growth to that observed with our best media (for example, fresh brewer's yeast and liver extract); (3) they effect an increase in the size of the larvæ; (4) they produce pigmentation of the bodies of the larvæ.

These findings serve to emphasize the close relationship known to exist between these factors and to indicate their possible identity. From the work of Elvehjem and his collaborators[5] it would seem that such concentrates as these may contain vitamins $B_{10}$ and $B_{11}$ in addition to folic acid. Thus while it is probable that the active factor in our preparations is folic acid, it cannot be regarded as certain.

It is known that xanthopterin may be present in concentrates of folic acid, and Mitchell[6] has provided some evidence of a structural similarity between the molecules of xanthopterin and of folic acid. The possibility that xanthopterin is active in bringing about pupation of *Aedes* larvæ was investigated, using the pure substance synthesized by a modification of the method of Purrmann[7]. It failed to bring about pupation, or any of the other changes characteristic of folic acid.

It is interesting to consider the possible mechanism by which these nutritional factors induce pupation. A number of workers have shown that moulting and pupation are caused by one or more hormones. In some insects the corpora allata have been proved to be the source of the hormone, while in others the source is uncertain. Our examination of 'Weismann's ring', which is thought by some to represent the corpora allata in mosquito larvæ, was inconclusive when carried out on normal fourth-stage larvæ from the insectary and on larvæ from a medium in which pupation will not occur. We have, however, noted a striking difference in the large œnocytes. In the larvæ from the insectary they are large, measuring up to 44 μ, and the cytoplasm is filled with numbers of vacuoles. In fourth-stage larvæ grown in a folic acid-free medium they are small, the largest measuring only 16 μ, and vacuoles are minute or entirely absent.

It is unlikely that 'folic acid' is itself a pupation hormone. This is indicated by the fact that transference of fourth-stage larvæ from a folic acid-free medium to one containing folic acid concentrate or brewer's yeast does not cause metamorphosis, whether the larvæ are transferred immediately after reaching the fourth instar, or eleven days later. On the other

hand, similar transference of newly moulted second- or third-stage larvæ results in normal growth, pigmentation and pupation. It seems probable, therefore, that folic acid functions by stimulating the production of a pupation hormone within the growing larva; but that it is incapable of doing so in a fully grown larva.

One final observation must be recorded here. In the insectary it is most unusual to find a weak adult mosquito, that is, one which on emerging cannot rise from the water. In our experiments, however, even on the most complete media, a large proportion of the adults were weak, irrespective of sex. Under the same conditions, when grown on contaminated media, all the adults were vigorous. There is thus some further factor, the nature of which we have not yet investigated, which is responsible for the development of vigorous adult mosquitoes.

We wish to thank the commanding officer, Technical Staff, Medical Laboratory Service, South African Medical Corps, who enabled one of us (M.L.) to participate in this investigation.

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[1] Trager, W., *Amer. J. Hyg.*, **22**, 18 (1935).
[2] Trager, W., *New Jersey Mosquito Extermination Assoc., Proc. Ann. Meeting*, **29**, 46 (1942). (*Chem. Abstr.*, **37**, 1517).
[3] O'Dell, B. L., and Hogan, A. G., *J. Biol. Chem.*, **149**, 323 (1943).
[4] Hutchings, B. L., Bohonos, N., and Peterson, W. H., *J. Biol. Chem.*, **141**, 521 (1941).
[5] Briggs, G. M., jun., Luckey, T. D., Elvehjem, C. A., and Hart, E. B., *J. Biol. Chem.*, **153**, 423 (1944).
[6] Mitchell, H. K., *J. Amer. Chem. Soc.*, **66**, 274 (1944).
[7] Purrmann, R., *Ann. Chem.*, **546**, 98 (1940). (*Chem. Abstr.*, **35**, 2147.)

## Effects of Secretions

SOME secretions of some organisms found to be inimical to some metabolic step necessary to the normal processes of some other organisms have come to be referred to as 'antibiotics'[1,2]. As has been pointed out by Lucas[3], it seems likely that it will be found profitable to regard such secretions as special cases of that great class of substances, distinguished by being physiologically active, the study of which constitutes a large branch of comparative physiology, and to consider their effects in terms of the evolution, by natural selection, of the organisms concerned. Their adverse effects on some organisms are presumably an example of these organisms not being adapted in a particular respect, comparable, in principle, with many other examples in ecology.

If this much be granted, then it would seem to become important that the nomenclature used in considering them shall be such as shall fit easily into the language of biological discussion. I suggest that 'antibiotic' is not such a word, and, further, that it contains implications contrary to what we believe to be the truth.

The word as it stands will, I think, suggest to nearly everyone 'opposed in general to the act of living'—in fact, a poison. But if my life is saved by penicillin, is the fact sufficiently reflected by calling penicillin an antibiotic in this sense? I think consideration of this difficulty, thus presented, may show that two mistakes have been made:

(1) It is not true, though it is implied, that penicillin (for example) is opposed to life in general. Few things are: one man's poison is notoriously another man's meat.

(2) It is true, though it is not stated, that because of the peculiar fact that penicillin (for example) is produced by certain organisms and adversely affects certain other organisms, it possesses the function, in Nature, not of forbidding life, but of precluding certain associations of living things, while permitting, or even encouraging, others. It acts upon a relationship.

Whether, on balance, life is increased or decreased as a result of the effects of one of these substances is likely to be almost impossible to determine. Whether more or fewer molecules are organized for life at any time than would have been without the action of the substance is a question which can scarcely be readily answered. Yet, this is just the question that the word 'antibiotic' appears to presume to answer.

Now, in medical practice, and in other branches of applied biology, the precluding of certain associations may seem to be the important thing. This one effect among many, therefore, is chosen as wanting a name. But this precluding of certain associations is not described in the word 'antibiotic'.

What we need is two words, one of which shall mean 'promoting certain associations of (perhaps named) living things', or, better 'promoting certain symbioses', and the opposite of that.

If, singling out for our own purposes one of its actions, we call a substance promoting certain such relationships a 'prosymbiotic', as I think we might, then perhaps we could call its opposite an 'antisymbiotic'. Thus penicillin could be called an antisymbiotic between *Penicillium notatum* and certain organisms which could be named as a group or individually as the context required. Penicillin could also be called a prosymbiotic between *Penicillium notatum* and certain other organisms as and when these came to be distinguished.

I make this suggestion tentatively, to direct attention to what I believe to be a serious conceptual confusion. I hope that others may improve upon it.

I think that these words can be applied in wider fields than that of bacteriology. They refer to the function of such substances, and to their origin in Nature. Of course, we may be able, for example, to take an antisymbiotic away from the organism producing it, or synthesize it, and use it in our attack on some organism adversely affected. But this artificiality does not affect the validity of the term.

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[1] Salisbury, E. J., *Nature*, **153**, 170 (1944).
[2] McIlwain, H., *Nature*, **153**, 300 (1944).
[3] Lucas, C. E., *Nature*, **153**, 378 (1944).

## Protective Action of Potassium Iodide on Thiourea Poisoning in Rats

KENNEDY[1], in reporting the goitrogenic action of the thioureas in rats, mentioned that doses of 200 mgm. of thiourea had no toxic action. This accords with the experience of Astwood[2]. On the other hand, MacKenzie and MacKenzie[3] found thiourea to be highly toxic to adult rats. During 1943 thiourea was administered to large numbers of rats in our laboratory with only infrequent deaths. Such deaths as did take place occurred on the first day of thiourea

administration, and autopsy disclosed a condition of pulmonary œdema and pleural effusion, as described by MacKenzie and MacKenzie. From the beginning of 1944 we have, however, experienced a heavy mortality in rats receiving thiourea. Up to 66 per cent of rats have died and the remainder have recovered only after a period of severe respiratory distress. The severity of the symptoms does not seem to be proportional to the dose of thiourea administered, and in susceptible groups of rats the provision of drinking water containing 0·025 per cent of thiourea has resulted in the death of 50 per cent of the animals. Plainly the response of our rats to thiourea administration has undergone an abrupt change. The same change in response was observed in two separate strains of rats, while no variation of composition of diet or environment had been consciously introduced. We are unable to account for this change but our investigations have confirmed the reported immunity[3] of young rats, and also of adult rats which have survived the first dose of thiourea.

Recently, it has been found that treatment with potassium iodide (1·3 mgm. by subcutaneous injection for four days) prevents the acute toxicity of subsequently administered thiourea. The iodide gave the same protection in thyroidectomized animals as in intact animals, so that this protection, like the toxicity, is unrelated to thyroid activity. Potassium bromide and potassium chloride in equivalent dosage did not exert a protective action.

The acute toxicity of thiourea resulting in pulmonary œdema has not been recorded in human beings. A number of minor toxic manifestations related to capillary permeability, namely, œdema of legs and of eyelids, watering of the eyes, and skin rashes have been recorded[4] in patients receiving thiourea for treatment of thyrotoxicosis. It is at present being tested whether simultaneous administration of iodide to such patients will lessen the incidence of such manifestations.

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[1] Kennedy, T. H., *Nature*, **150**, 233 (1942).
[2] Astwood, E. B., *J. Pharm. and Exp. Therap.*, **78**, 79 (1943).
[3] MacKenzie, J. B., and MacKenzie, C. G., *Proc. Soc. Exp. Biol. and Med.*, **54**, 34 (1943).
[4] Ritchie, F. L., and Geddes, B. L., *Med. J. Australia*, **1**, 381 (1944).

## Graphical Representation of Growth Gradients

GROWTH gradients in animals have been represented by a method described by Huxley[1], based on growth constants, that is, the values of $\alpha$ in the allometry formula[2], $y = bx^{\alpha}$. Huxley[1] has discussed the inadequacy of his graphical method and the formal difficulties of devising a better, but no attempt seems to have been made to overcome these difficulties. It is thought that the simple mathematical considerations below constitute a solution to the formal obstacles in the way of the quantitatively accurate representation of certain types of growth gradient. The gradients referred to here are gradients in heterauxesis[3] in which the growth intensities are in the direction of the axis along which the gradient lies. Multiplicative growth in length only is discussed, but similar concepts apply to multiplicative growth in area, volume and weight.

If there is a growing axis, and in it a morphologically differentiated point of reference, $O$, and other similarly differentiated points $A$, $B$, $C$, . . ., $Y$, . . . , the lengths of the regions $OA$, $OB$, $OC$, . . . , $OY$, . . . , can be considered in two ways, namely, (1) throughout growth, as functions of the length of some standard region of the body, and (2) at any particular moment during growth, as special values of the length $OR$, where $R$ is a point of variable position in the axis, that is, $OR$ is an independent variable. Regarding the above regions in sense (1), the significant expression of the growth-rate of a morphologically differentiated region $OY$, of length $y$, relative to the standard dimension, $x$, may be given by the relative specific growth-rate, or growth potential, of $OY$, $P_{OY} = \frac{dy}{dx} \cdot \frac{x}{y}$. As defined, $P_{OY}$ may or may not remain constant during growth, so that it is not necessarily equivalent to a growth constant. Growth potential is adopted for the present purpose because it is a more general conception than growth constant, and because the mathematical inconsistencies in the additive properties of growth ratios are avoided. Regarding the regions in sense (2), when the standard dimension equals $x$, the growth potential $p_R$, *at the point* $R$ in the direction of the axis, may be defined as the limit of $P_{RS}$ as $RS$ tends to zero, where $S$ is another point of variable position in the axis. The direction of the growth potential at a point must obviously be specified.

Let $OR = z$, which, it should be emphasized, is an independent variable. Now, if growth potential is an adequate indication of growth intensity, and if the idea of growth gradients is fully justified, at any stage of growth $p_R$ should be a function of $x$ and $z$, that is,

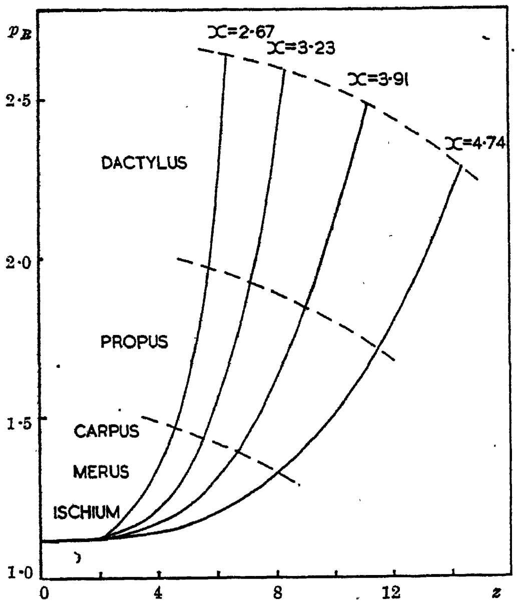
$$p_R = f(x,z). \qquad (1)$$

Furthermore, for any particular value of $x$, $p_R$ should be a *continuous* function of $z$. Equation (1) can be represented by a number of curves in one plane, and such a curve diagram will be a quantitatively accurate picture of the growth gradient. The curve for any particular value, say $k$, of $x$, may be derived as follows. It can be shown mathematically that $P_{OR}$ is equal to the arithmetic mean of the growth potentials in the direction of the axis at all points in $OR$. Combining this fact with equation (1) we have

$$[P_{OR}]_{x=k} = \frac{1}{z}\int_0^z [p_R]_{x=k}\, dz. \qquad (2)$$

Hence, if particular values of $P_{OR}$, namely, $P_{OA}$, $P_{OB}$, . . . , are known, and if the morphologically differentiated points $A$, $B$, . . . , are sufficiently numerous and suitably spaced, a graphical representation of equation (1) may be obtained graphically by means of equation (2) or a transformation of equation (2).

For the above method of analysis it is necessary to know the lengths of several successive morphological regions, adjoining end to end, for a number of different body sizes. There are very few data of this kind in the literature, but the accompanying figure is the outcome of an analysis of the data given by Tazelaar[4] for the segment lengths of the chela of the male prawn *Palæmon carcinus*, for carapace




GRADIENT OF LENGTH-GROWTH IN THE CHELA OF THE MALE *Palæmon carcinus*.

The growth potentials, $p_R$, at points have been plotted against the distance, $z$, in cm. distal to the basal end of the ischium for different carapace lengths, $x$, also in cm.

length 2·67–4·74 cm. The data were not designed for this purpose, however, and the figure should be regarded as an example of the method rather than a very accurate representation of the growth gradient. It was found convenient to employ a transformation of equation (2), namely,

$$p_R = [P_{OR}]_{x=k} + z\frac{d}{dz}[P_{OR}]_{x=k}. \qquad (3)$$

The curves of the figure correspond to values of $x$ in geometrical progression, which seems logical since growth is a multiplicative process.

It has been pointed out to me by Mr. E. D. van Rest, to whom I am much indebted for criticisms and suggestions, that there is more to the problem than this short account might suggest. For example, growth potential at a point as defined is determined partly by the length of the standard region, which may itself be subject to variations in growth potential from point to point. It is hoped to discuss this and other questions elsewhere.

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[1] "Problems of Relative Growth" (London, 1932).

[2] Huxley, J. S., and Teissier, G., *Nature*, 137, 780 (1936).

[3] Huxley, J. S., Needham, J., and Lerner, I. M., *Nature*, 148, 225 (1941).

[4] *Arch. Entw. Mech.*, 129, 402 (1933).

## Kemp in New Zealand Romney Sheep and its Significance for Mountain Breeds

SELECTION against kemp in the Romney is a simple matter, scarcely amounting to a breeder's problem, but facts learnt from Romneys may be offered to breeders of mountain sheep that characteristically have hairy birthcoats. In Romney sheep, selection against high abundance of halo-hairs is a sufficient safeguard against kemp, and selection against halo-hairs is effective. On the backs of lambs with abundant halo-hairs (large birthcoat kemps of generation I, $G_1$), there may or may not be secondary kemp. Birthcoat kemps are shed around the third month after birth. Halo-hairs are nearly always all shed. Occasionally an odd halo-hair is of indeterminate growth. Super-sickle-fibres, whether in non-plateau or plateau arrays, sickle-fibres which are the key type in non-plateau arrays, and hairy-tip-curly-tip fibres which are the key type in plateau, vary in their shedding from all to none. The shed birthcoat fibres are succeeded by other fibres which when they are shed are later, or secondary, kemps. In non-plateau, later kemp is grown mostly in the follicles of the halo-hairs, occasionally, as we conclude, in some super-sickle-fibre follicles, scarcely ever in those of sickle-fibres. In plateau, super-sickle-fibres and hairy-tip-curly-tip fibres, as well as the very abundant halo-hairs, are readily followed by kemps, so that there is often a huge amount of secondary kemp in N-type lambs.

In non-plateau fibre type arrays the successors ($G_2$ fibres) of halo-hairs are shed freely, that is, are kemps, only when a substantial majority of the sickle-fibres with bigger sickle-ends are shed. When the shedding of sickle-fibres is less than very free, there is a certain correspondence in extent of shedding of sickle-fibres and of $G_2$ fibres. Kemp is plentiful among the successors ($G_3$), grown at seven months and later, of the shed successors ($G_2$) of halo-hairs, only when the array is one indicative of a weak pre-natal check, namely, saddle or a near approach to saddle. When the array is valley there is little $G_3$ kemp, and saddle *v.* valley is a matter of strong inheritance.

When kemp succession relations were defined in non-plateau arrays it was expected that a corresponding generalization could be made for plateau array. This is the array, typically lacking sickle-fibres, of N-type lambs, these being like hairy mountain lambs. A study (by J. M. R.) of succession on the back of eighty covered lambs has improved upon an earlier generalization. When the shedding of hairy-tip-curly-tip fibres is very free (on present data more than 45 per cent) there is much $G_2$ kemp. When there is no shedding of hairy-tip-curly-tip fibres there is little $G_2$ kemp. When the shedding of hairy-tip-curly-tip fibres is intermediate there is great diversity in the $G_2$ kemp figures. Higher abundance of hairy-tip-curly-tip fibres (on present data more than 26 per 500 fibres of the lamb's full fleece) is then accompanied by much $G_2$ kemp, lower abundance of hairy-tip-curly-tip fibres by little $G_2$ kemp. Intermediate abundance of $G_2$ kemp shows signs of being associated with very poor shedding of hairy-tip-curly-tip fibres, or with low numbers of these fibres. In plateau array abundant $G_2$ kemp is almost always followed by plentiful $G_3$ kemp. In both non-plateau and plateau arrays when $G_3$ kemp is plentiful, $G_4$ kemps have often at least started to grow before shearing at about fifteen months. The expectation that kemp succession relations in plateau would show a general similarity to those in non-plateau has been justified. In both non-plateau and plateau arrays a small number of exceptions to our generalizations have been found, but they lend themselves to explanations that seem both reasonable and instructive.

There is some evidence that abundance of secondary kemp in N-type is inherited. In breeding experiments on the genetics of N-type it has often happened, partly incidentally, partly by choice, that both parents have had much $G_2$ kemp. The large proportion of resulting lambs with much $G_2$ kemp suggests that this selection has been effective. Small attempts

to breed against $G_2$ kemp in N-type have, however, achieved little, but the rams hitherto available have not been so free from $G_2$ kemp as one would have wished. There is also an argument by analogy from the inheritance of birthcoat characters. Abundance of halo-hairs and fibre type array, as stated earlier, are strongly inherited. The freedom from chalkiness, that is, no medulla or no appreciable medulla, in the post-natal region and, besides, in the sickle-end, of all sickle-fibres in numerous Wensleydale specimens sent from England by Dr. K. M. Rudall, is manifestly inherited. These facts, and especially the last detail, suggest that the hairiness (chalkiness) of the tips of fibres of the curly-tip group in N-type is likewise genetically determined, and consequently that the abundance of secondary kemp is inherited. Bryant secured direct evidence from a Scottish Blackface flock.

Our fundamental aim is to understand the interaction of forces at work in the follicles. Our present purpose is to point to possible application of our findings in selection against later kemp in mountain sheep in which a kempy birthcoat is accepted and desired. In particular, it may prove practicable to judge very young lambs for later kempiness. Biological work on the fleece is slow, especially when breeding is involved, and we are therefore presenting this preliminary report on new facts about secondary kemp in N-type Romney lambs.

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Bryant, *Emp. J. Exp. Agric.*, 4 (1936).
Dry, *J. Text. Inst.*, 24 (1933) and 26 (1935).
Dry, *N.Z. J. Agric.*, 46 (1933) and 48 (1934).
Dry, *N.Z. J. Sci. Tech.*, 22 (1940).
Dry, McMahon and Sutherland, *Nature*, 145, 390 (1940).
Dry and Sutherland, *Nature*, 148, 563 (1941).

## High Fertility of Buckwheat Tetraploids obtained by Means of Colchicine Treatment

IN the summer of 1941, extensive experiments were performed on producing buckwheat tetraploids by means of colchicine treatment. In 1942 the root tips of a thousand seedlings grown from seeds of the initial experimental plants were studied cytologically. Among the seedlings verified cytologically, 250 bore the tetraploid chromosome set (32 instead of the normal 16). Tetraploids were obtained from 79 initial plants of the following nine buckwheat varieties: 'Bolshevik', 37 initial plants; 'Kharkovskaya', 10; 'Bogatyr', 6; 'BTSKA' (-Timiriasev Agricultural Academy), 6; 'Altaiskaya', 5; 'Ispanskaya serebristaya', 5; 'Kazakskaya', 5; 'Belorusskaya', 3; and 'Buriat-Mongolskaya', 2.

In the summer of 1942, the non-crossability of the buckwheat tetraploids with buckwheat diploids was confirmed, this fact being of outstanding importance for selection.

The comparative study of tetraploid plants carried on in 1942 and 1943 invariably showed a marked increase in size of seed (on the average surpassing the weight of the diploid seeds by 42–85 per cent along with general enlargement of the plants).

As is usually the case in autopolyploidy, the majority of the new buckwheat forms were marked by a pronounced decrease in fertility as compared with the diploid plants. However, our extensive initial material, hereditarily different both as regards the nine varieties and within each variety as well, made it possible to select for reproduction those plants which were marked by the largest seeds and by greatest fertility. Subsequent selection of their progeny (for some stocks four generations of tetraploids were obtained for two years) already in 1943 showed a number of autotetraploid highly fertile buckwheat stocks with large seeds.

In the progeny of the best tetraploids of the variety 'Bolshevik', we obtained on the average from double to four times more seeds than from the diploids. Thus along with the greater weight of the seeds (1·5 times heavier) this latter fact increased the crop from the tetraploid plants from three to six times as compared with the normal diploids. Alone, 'Bolshevik' had produced in 1943 more than 15 kgm. of seeds.

The main theoretical importance of the data obtained consists in the fact that buckwheat is the first case illustrating high fertility of an experimentally produced, agriculturally valuable autopolyploid form. Of practical importance is the fact that during the shortest possible period (two and a half years) highly fertile buckwheat forms with large seeds have been produced, non-crossable with the initial diploid plants.

Some data point to the assumption that owing to their vigorous growth tetraploids show a higher percentage of germinating seeds under field conditions, as compared with the diploids. They are more frost-resistant and they show more pronounced self-pollination, which is seldom noted for normal buckwheat forms.

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## Lunar Coronæ

A DISPLAY of lunar coronæ was seen here in alto-cumulus cloud on October 2 between 10.30 and 11.30 p.m. At its greatest extent the red ring of the third order was visible, but those parts of the corona outside the second red ring were fragmentary. On at least one other occasion the whole corona up to the green of the second order was seen.

Some measurements were made towards the end of the observations, and these and the calculated diameters of cloud droplets are recorded in the accompanying table. The unit of angular measurement is the moon's radius.

| Cloud | Aureole radius | Droplet size (mm.) | Second red ring radius | Droplet size (mm.) |
|---|---|---|---|---|
| *A* | 13 ± 1 | 0·012 ± 0·001 | — | — |
| *B* | 6 ± 1 | 0·025 ± 0·004 | 12½ ± 1 | 0·022 ± 0·002 |
| *B* | 7 ± 1 | 0·022 ± 0·004 | — | — |

In addition to the error due to the crudity of the measurements, the finite diameter of the moon introduces an uncertainty about which little appears to be known.

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# RESEARCH ITEMS

### Irish Fisheries

Continuing his researches on Irish freshwater fisheries Arthur E. J. Went has published a further study of the sea trout of the Waterville (Currane) River (*Sci. Proc. Roy. Dublin Soc.*, **23** (N.S.), No. 20; 1944), following the work of Went and Barker (1943). It was found in the latter report that the calculated smolt-length of the spring-running sea trout was exceedingly high and the question arose as to whether the later-running smolts had similar high mean lengths, and if so whether these were taken inadvertently by anglers before their descent to the sea in the belief that they were small adult sea trout. It is found by examining new material that the spring-running fish are merely part of the general stocks of sea trout in the Waterville River system and not different from the late-running fish. The rapid growth in fresh water and the large size attained by the smolts are, more or less, unique so far as sea trout have been investigated to date. A second paper by A. E. J. Went (*Proc. Irish Acad.*, **49**, C, No. 5; May 1944) gives an account of the modes of fishing in the Galway Fishery. In 1942 Mr. Went gave a detailed review of the ownership of the fishery in the same publication (**48**, C, No. 5). In the present work the various fishery methods are described, the sites of the fishing engines and certain other data, in order to make it more or less complete.

### Some Primitive Bony Fish of the Middle Coal Measures

A monograph on the Haplolepidæ, published by T. S. Westoll (*Bull. Amer. Mus. Nat. Hist.*, **83**, 1; 1944), is an important contribution to the analysis of the group of primitive bony fishes included in the Palæoniscidæ. It includes not only an exceptionally complete and detailed account of the superficial anatomy of these fish, but also a most interesting discussion of the functional significance of their peculiarities, and of their possible habitat. The family includes two genera only, one divided into two sub-genera, all being found in the "Middle Coal Measures" of Europe and North America in identical form. Dr. Westoll points out the remarkable fact that in four out of six of the localities in which Haplolepids are found they are accompanied by highly peculiar and specialized amphibians, Nectridia and Asistopoda, which are known from only one other "M. Coal Measure" locality, although they occur unaccompanied by Haplolepids in some six localities of later date. This remarkable association, taken in connexion with the very small size of the fish and Amphibia, raises very interesting consideration of Coal Measure geography. Finally, Dr. Westoll's monograph includes a series of very interesting discussions of the morphology of Actinopterygians in general and the course of evolution of their early members.

### Development of Male Daphnia

D. J. Scourfield has investigated the post-embryonal development of the male of *Daphnia magna* (*J. Quek. Micro. Club*, (4), **1**, No. 6; 1943). Although the development of the female has long been known to a certain extent, this is not the case with the male, and these observations are new. Males are much rarer than females, but the author has obtained the first post-embryonal stage by isolating females until they give off broods of males. This first stage, the so-called neonata, is very like that of the female except for the larger antennules, which are distinctly jointed to the head, and a rounded instead of a pointed rostrum. The changes undergone during the post-embryonal stages (usually four) are significant though small. Perhaps the most interesting point in the life-history is the fact that many species of *Daphnia* hatch while still enclosed in an embryonic cuticle in which the young may swim about for some hours, although not feeding. The shell spine is held between the ventral edges of the valves. Traces of antennæ which are free and traces of claws and setæ seem to show that this represents an embryonic stage (presumably a nauplius) usually passed through before hatching; in this it resembles the embryonic cuticle (pre-zoeal) of the decapod Crustacea, which in all probability also represents a nauplius stage.

### Nutritional Physiology of the Silkworm

In a recent review of Soviet researches on the physiology of the silkworm, S. Y. Demyanovski (*Advances in Modern Biology, Moscow*, **16**, 1; 1943) summarizes some outstanding findings referring to protein metabolism in relation to silk secretion. Tryptase proved to be the chief proteolytic enzyme, while dipeptases and polypeptases are absent, and such proteases as may be introduced with plant food are inhibited by the high *p*H value (9·9–10·1) of the digestive juice. Studies of the digestive process established that the proteolytic activity of the digestive juice can be augmented by the addition to food of saccharose or of fructose, the first increasing that activity by 10–12 per cent and the second by 20–50 per cent. This discovery has important practical implications, since by feeding silkworms on mulberry leaves with the addition of saccharose the weight of the larvæ was increased by 38 per cent, as compared with the controls fed on untreated leaves; the weight of cocoons rose by 12 per cent; the length of silk thread increased by 4·5 per cent, its weight by 19 per cent, the thickness by 7 per cent; and the output of silk was 7·8 per cent above that of controls. These experiments were repeated for four years on a number of varieties of silkworm, with consistent results. The best results were obtained when the ratio of saccharose to fresh leaves was 1·5 per cent by fresh weight; greater amounts of saccharose produced a further increase in the weight of the larvæ and fresh cocoons, but not in the output of silk; additional saccharose appears, however, to result in an increased fertility of the moths.

### Genic Action

C. Stern (*Genetics*, **28**, 441; 1943) has published the first of a series of papers on the phenotypic reactions of *Cubitus interruptus* which affects the veins of *Drosophila melanogaster*. He shows that there is a dosage effect of this gene in that an increase in their number approaches the normal wing type of the wild-type allelomorph. On the other hand, the presence of a wild-type allelomorph produces an antagonistic effect when the *ci* gene is increased in number. In such cases the *ci* gene may behave as a dominant instead of as a recessive. The addition of the residue of chromosome IV may also transform *Cubitus interruptus* into a normal phenotype. The author tentatively suggests that each allelomorph has two properties, (1) a combining power, or the degree

of interaction with the substratum, and (2) an efficiency factor which measures the effectiveness of interaction to form the product which is efficient in the elaboration of a normal phenotype. This hypothesis leads to statements regarding the excess or deficiency of combining power and the amount of substratum in relation to the *ci* and wild-type allelomorph.

### Chromosome Numbers in Guayule and Mariola

*Parthenium argentatum*, guayule and *P. incanum*, mariola, have come into prominence as sources of rubber. G. L. Stebbins and M. Kodani (*J. Hered.*, **35**, 163; 1944) have made a cytological examination of strains of these shrubs from various wild sources and of their progenies. There is a large variation in chromosome number; *P. argentatum* had chromosome numbers of 36, 38, 54, 72, 74 and 108–111; *P. incanum* had 54, 72 and 90 chromosomes in the somatic tissue. This large range in polyploidy appears to have a basic chromosome of nine. Plants with 72 chromosomes in *P. argentatum* produce both pseudo haploids (36 chromosomes) and autotriploids (108–111). The fertility and seed fertility bear a relationship to the meiotic irregularities seen in the different polyploid plants. The evolution and relationships of the forms are discussed.

### Combustion Mechanisms and Continuous Spectra in Flames

IN following the details of combustion mechanisms, little information can be got from line spectra. Whereas band spectra are of value in telling us what molecules and radicals are present under flame conditions, still more information about *processes* such as dissociation, ionization and association can be got from studying continuous spectra. The causes and types of continuous spectra emitted by flames have been discussed by A. G. Gaydon (*Proc. Roy. Soc.*, A, **183**, 111; 1944). It is shown that the yellow-green continuous spectrum emitted by some flames containing oxides of nitrogen is probably identical with the spectrum of the air afterglow and is therefore due to a reaction between nitric oxide and atomic oxygen. The presence of atomic oxygen in a flame can therefore be tested by admitting nitric oxide and observing if a yellow-green emission results. For the carbon monoxide flame there appears to be a high concentration of atomic oxygen, both for the dry and moist flame. The combustion mechanism is discussed in detail using this knowledge. For the hydrogen flame a little atomic oxygen is present, but results do not permit of definite conclusions. For hydrocarbon flames there is no sign of atomic oxygen in the inner cone, and this is taken as strong evidence in favour of a peroxide rather than a hydroxylation mechanism.

### Existence of Ammonium Hydroxide

THE question whether ammonium hydroxide really is present in aqueous solutions of ammonia has frequently been raised and some chemists hold that its existence has never been definitely proved. Both Walker in 1903 and Blackman in 1907 adduced evidence, based upon conductivity measurements, in support of the view that ammonium hydroxide was present in relatively small concentrations, and the matter has again been investigated by Briegleb (*Naturwiss.*, **30**, 506; 1942), who sought to discover (1) how ammonia is bound with water in solution, and (2) whether ammonium hydroxide does exist and, if so, whether it is a strong or weak base. In the gas phase the heat of reaction

$$NH_3 + H_2O = NH_4OH$$

was found from proton affinity and polarization methods to be $-$ 49 kcal., if the intramolar distance is 2·5 A. If it is 3 A. then the heat absorbed is 74 kcal. This strongly endothermic reaction is taken to prove that ammonium hydroxide does not exist in the gaseous state. The heat of formation of aqueous ammonium hydroxide is calculated at $-$ 30 (or $-$ 50) kcal., while the heat of reaction

$$NH_3 + H_2O = NH_4^{+}aq. + OH^{-}aq.$$

was found to be between $-$ 1·5 to $-$ 2·0 kcal. The experimental evidence also points to the existence of the hydrates $NH_3,H_2O$ and $2NH_3,H_2O$ with but little formation of $NH_4OH$, which would therefore be almost completely dissociated into ammonium and hydroxyl ions. The thermochemical data are said to accord with observed Raman effects and it is equally evident that ammonium hydroxide is a strong base. The evolution of ammonia from ammonium salts by stronger bases, the neutralization of acids by solutions of ammonia and the hydrolysis of ammonium salts are all explicable, according to Briegleb, in terms of proton affinity.

### Peculiar Stars

GEORGE H. HERBIG has an article with the above title in Leaflet No. 182, April 1944, of the Astronomical Society of the Pacific. He deals with a number of abnormal stars such as ε Aurigae, ζ Aurigae, β Lyrae, etc., and gives a brief outline of the most recent theories advanced to explain these freakish stars. In the case of ε Aurigae we now regard it as a hot, yellowish-white giant accompanied by a huge dim star which is invisible, and which has a diameter 2,700 times that of the sun. Its surface temperature is about 2,000° F., and hence most of its radiation must lie in the infra-red. The β Lyrae system is composed of two giant stars distorted by their mutual gravitation into egg-shaped bodies, their period of revolution around their common centre of gravity being 12 days. An incandescent torrent of gas pours from the larger star, and passing round the smaller one, is ejected into space, where it forms a gigantic expanding pin-wheel about the system. The variable star RW Tauri is a most remarkable system. The smaller white component is hotter and brighter than the larger, cooler, orange companion, and owing to the inclination of their orbit to our line of sight, the principal eclipse is total. Using the 100-in. telescope at Mount Wilson, A. H. Joy has obtained results which indicate the presence of an extended gaseous ring above the equatorial regions of the smaller, brighter star. This suggests an analogy with the rings of Saturn, though a difference arises from the fact that the ring of the RW system is gaseous. The diameter of the ring is about four times that of the sun and its orbital velocity is two hundred miles a second. When the larger star has just covered the disk of the smaller one an edge of the glowing ring is visible for a short time. The question of the existence of such appendages in other stars arises, and it is owing to the relative sizes of the components of RW Tauri and the orbital tilt that the ring has been detected. It is very probable that other stars have similar rings, and if so, some new and interesting problems confront the astronomer.

# ANOMALOUS DISINTEGRATION OF NUCLEI BY COSMIC RAYS

By PROF. A. JDANOV
Radium Institute, Academy of Sciences of the U.S.S.R.

As is well known[1], one effective method for the observation of the disintegration of atomic nuclei by cosmic rays is the method of the 'thick-layer' photographic plates suggested and developed in the Radium Institute of the Academy of Sciences of the U.S.S.R.[2]. The tracks of these disintegrations in such plates are mostly in the form of forks with irregular angular distribution ('stars'). They correspond chiefly to protons, more seldom to $\alpha$-particles and still more seldom to particles with a stronger 'ionization power'. The 'yield' of nuclear disintegrations at sea-level is approximately $8 \times 10^{-3}$ disintegrations in an hour per 1 cm.$^2$ of the area of the plate. This yield rapidly increases with height, reaching a value fifty times greater at a height of 7,000 metres[3]. At sea-level the greatest percentage of disintegrations corresponds to the triple forks. Forks with five tracks are met comparatively seldom, and only with the increase of height is the slow increase of the number of ejected particles in one disintegration observed. In addition to the disintegrations in the form of stars, there are observed also disintegrations in the form of 'showers', that is, in the form of forks with a pronounced unilateral direction of tracks (inside the narrow solid angle). Tracks in the showers may belong to protons as well as to mesotrons. We suggested in previous papers[4] the possibility of the registration of slow mesotrons in the 'thick-layer' plates, and also the possibility of estimating their mass from the average distance between two neighbouring developed grains. In one of our papers[5] there was shown a shower consisting of about a hundred heavy particles, which was obtained on a plate exposed at a height of about 9,000 metres.

At the end of November 1942 we observed[6] the anomalous 'yield' of nuclear disintegrations; here and there on several plates this yield exceeds by $10^3$ times the normal value ($10^{-3}$). (We take account only of those disintegrations and single tracks for which the range is more than 10 cm. of air equivalent.) Just about the same time we succeeded in registering a series of the showers at sea-level. These showers are probably in many cases the complete disintegration of a nucleus into all its components. Such disintegration may be called an 'anomalous' one. Below are given the description and the results of the measurements of two showers, photographs of which are shown in Figs. 1 and 2 (stereomicrophotographs). In Fig. 3 the energy spectra of protons are shown; the number of tracks is plotted against the energy in MeV. at intervals of 0·5 MeV. (positions of separate tracks are indicated by points). The first shower consists of 35 tracks, all corresponding to protons, and it is quite natural to attribute it to the anomalous disintegration of the nucleus of bromine in the photographic emulsion. Measurement of the ranges gives the total energy of protons as $\Sigma E_H \sim 80$ MeV. Assuming that the emitted neutrons have on the average the same energy as protons and taking into account the binding energy of the nucleus $\Delta M \sim 8{\cdot}5\,A$ MeV., where $A$ is the mass number, we obtain for the minimal energy of the incident particle $E_N = \Sigma E_n + \Sigma E_n + \Delta M \sim 900$ MeV.

It is of interest also to consider the momentum of all the particles emitted. Measurement shows that

10 cm. of air equiv.

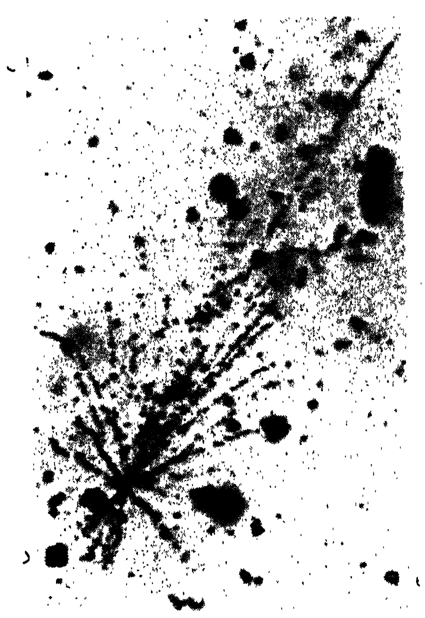

FIG. 1.

10 cm. of air equiv.

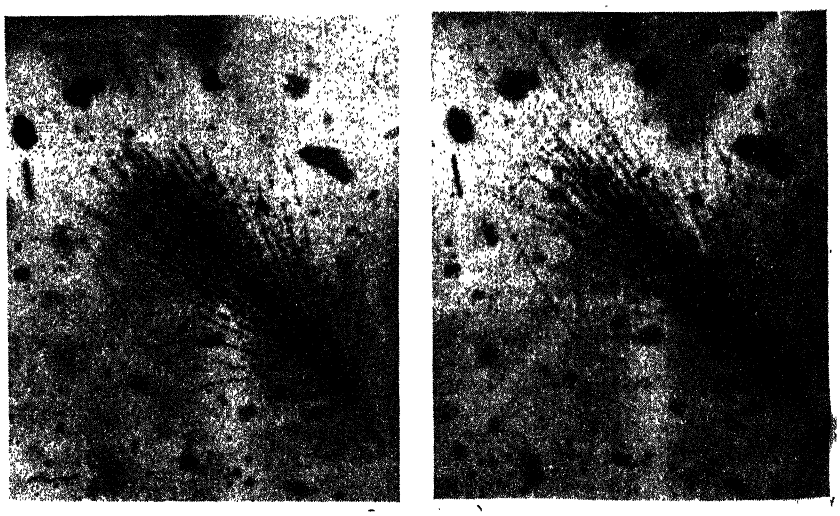

FIG. 2.

the sum of the projections of the momenta of protons on the axis of the shower is $P_H = \Sigma\sqrt{E_H m_H}\cos\alpha = 17{\cdot}6 \sim 20$. Assuming that the total momentum of the neutrons has approximately the same value as that of the protons, we obtain the value of $\sim 40$ for all the particles from nucleus. If we calculate the momentum, $P_N = \sqrt{E_N m_N}$ from the value of the energy of the incident particle, we obtain $P_N \sim 30$ in the case of $m_N = 1$. This number is in satisfactory agreement with the value measured from the photographs.

In the second shower there are about fifty tracks and therefore it is reasonable to consider it as the anomalous disintegration of the silver nucleus. Measurement of the particles of the shower shows that $\Sigma E_H \sim 150$ and $P_H = \sim 70$. In this case the minimum energy of the incident particle is $E_N \sim 1{,}300$ MeV. and $P_N \sim 35$ (for $m_N = 1$).

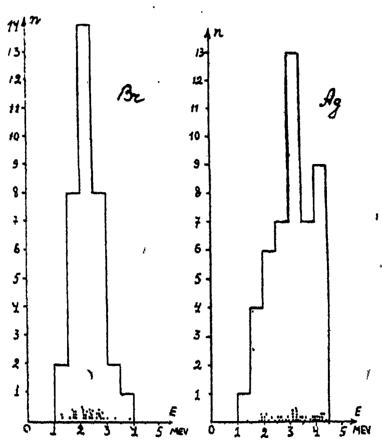


FIG. 3.

It should be noticed that $P_N$ is in both cases somewhat less than $P_H + P_n$.

If the disintegrations were due to photons, electrons or even to mesotrons, the momentum would have quite another order of magnitude. It is interesting to notice that all the particles in the showers are emitted within a cone the cross-section of which is a very eccentric ellipse. For example, in our cases the ratios of the axes of the ellipses are $0{\cdot}13$ and $0{\cdot}15$, and for the shower described in the previous paper[5] is $0{\cdot}1$. This eccentricity of disintegrations can be explained by the fact that the collision between the cosmic particles and the nucleus is non-central.

Thus the existence of the showers shows the presence of heavy particles of mass $m \simeq 1$ and energy $\sim 10^9$ eV. in the cosmic radiation at sea-level.

Further details and examples of anomalous disintegration of nuclei will be submitted to the *Physical Review*.

[1] Shapiro, M., *Rev. Mod. Phys.*, **13**, 58 (1941).
[2] Myssovsky, L., and Tschishow, P., *Z. Phys.*, **44**, 408 (1927). Jdanov, A., *J. Phys. et le Rad.*, **6**, 233 (1935).
[3] Jdanov, A., *Bull. Acad. Sci. URSS.*, **4**, 266 (1940).
[4] Jdanov, A., *C.R. Acad. Sci. URSS.*, **28**, 109 (1940). Pilippov, A., Jdanov, A., and Gurevich, I., *C.R. Acad. Sci. URSS.*, **18**, 169 (1938); *J. Phys. U.S.S.R.*, **1**, 51 (1939).
[5] Jdanov, A., *Nature*, **143**, 682 (1939); *C.R. Acad. Sci. URSS.*, **23**, 29 (1939).
[6] Jdanov, A., Perfilov, N., and Deisenroth-Myssowskaya, M., read at the meeting of the Chemical Department of the Academy of Sciences of the U.S.S.R., Feb. 6, 1943, and sent to the *Physical Review*.

# INDIAN FOREST WAR-TIME PRODUCTS

WHEN Lord Curzon, Viceroy of India, sanctioned in 1906 the institution of a Forest Research Institute, with headquarters at Dehra Dun, even so wide-visioned a man as he could not have anticipated the great benefits it was to confer on India. Even during the War of 1914–18 the imports into India of what had previously been deemed necessaries of life were curtailed, and forest research at once stepped into the breach and by the close of that War had not only established its position but had outgrown all the buildings, equipment and so forth for which provision was made by 1914, although it was considered sufficient for the next score of years. A great new building and much additional equipment was sanctioned by 1920 and has long been functioning. During the present War, in some directions the Institute has been able to answer urgent imperative calls of both Army and public. Curiously enough, although the chief branches of forestry were catered for, including utilization, which assumes such an important place in war-time, it was not until comparatively late in its existence that the importance of the minor products of the Indian forests, admittedly a sub-branch of utilization, received due recognition at the Institute—or perhaps at the hands of Government—a special branch being at length formed which has proved of the very highest value, especially in combination with the Chemical Branch, during the present War. Some of this work has already been noted in these columns. Two *Indian Forest Leaflets*, Nos. 60 and 64, Sylviculture (Forest Research Institute, Dehra Dun, 1944), issued recently, deal with two further products of the Indian forest.

No. 60 is entitled "Short Note of the Beedi Leaf Industry". Beedis are locally made Indian cigarettes with leaf wrappers. As an article of merchandise the industry is believed to have started between 1905 and 1916 in different parts of India, chiefly in Bihar, the Central Provinces, the Eastern States and Patna. The traditional smoke of the Indian is the hookha and chilam. For purely agricultural pursuits the hookha is not an encumbrance, but it is difficult to carry about, and the chilam is a fragile article. With increased industrialism and faster travel by rail and motor-car, the need for a cheap and more portable smoke was met by the cheap foreign cigarette. Supplies of these became difficult to obtain during the War of 1914–18, and the beedi began to become known. The use of leaves of local tree species for making pipes was a common practice of many tribes; it was a short step therefrom to using leaves for preparing cheap cigarettes, and the present War has given a great impetus to this manufacture, expanding industry and the great increase in the Indian Army being two important factors.

The leaves of many indigenous plants are used for wrapping tobacco in, but *Diospyros Melanoxylon* is the one generally preferred owing to its peculiar flavour, flexibility in texture and resistance to early decay. It occurs in the southern two thirds of India proper from, roughly, an east and west line approximately a hundred miles to the north of Calcutta. Other leaves used are those of *Bauhinia racemosa* and *B. vahlii*, *Butea frondosa*, *Castanopsis indica* and *Shorea robusta*. The supply of the leaves is eminently a forestry industry, and the best methods of obtaining the maximum crop of leaves, whether

by pollarding, coppicing or root-suckers, are being closely investigated. The pamphlet deals with the financial and industrial aspects, period of collection of the leaves and grading, drying, still under experiment, storage, packing and transport.

Leaflet No. 64, on "The Growing of *Cryptostegia grandiflora* as a War-time Emergency Crop", describes another and more important war-time object, namely, the production of rubber. *Cryptostegia grandiflora* is indigenous to Madagascar and probably to Africa. The plant is described as a scrambler; it grows erect until about 1½ ft. high and then it climbs and scrambles until after some years it can again stand by itself. It is therefore greatly helped in its early development if it has something to climb on. It was imported into India many years ago as a garden plant for its flowers. It has since run wild in many places, generally in arid or semi-arid climates; for example, Kalka near Delhi, Muttra near Poona, Hyderabad (Sind), etc., with a rainfall of 5–25 in. and elevations up to 1,500 ft. In such situations it was noticed that the best development occurred on land subject to local inundations, but it obviously could withstand arid conditions. A survey by the Indian Agricultural Research Institute revealed the fact that it was present in all parts of India in various soils; namely, black, brown, red, laterite, Indo-Gangetic alluvium, sands, clays, acid and alkaline soils; in all climates without regard to temperature, rainfall, humidity, light, wind and exposure; on river banks and where the subsoil water table is high—an amazing power of adaptation. It is considered probable that a well-drained fertile soil with a gentle slope at about 1,000 ft. elevation and a rainfall of 60 in. will suit it best, particularly if it can be irrigated during periods of dry weather.

Since the Japanese occupation of Malaya and the Dutch East Indies, which deprived the Allies of some 90 per cent of their supplies of raw rubber, much work has been done on the possibilities of developing additional war-time supplies of vegetable rubber. The *Cryptostegia* in question has proved a most promising plant, and in the past eighteen months or so experimental work has been carried out and large-scale experience gained. Most of the publications on this work have been academic rather than practical. The present pamphlet, it is emphasized, only sets out to give the information at present available, based on a year's practice in planting plantations of the plant for the sole purpose of obtaining the maximum production of rubber in the minimum time, the question of costs not being of primary importance. A better plantation technique will be a matter for the future should this type of cultivation be found remunerative after the War. The seed is sown in nurseries and the seedlings put out at the outbreak of the rains when about two months old. They are planted in lines or double lines about 6 ft. apart to allow room for the tapping operations to be undertaken. Each row has a simple form of fence 4 ft. 6 in. high on which the plants can climb. Since the object is to obtain maximum results in the shortest time, dense planting is necessary. "Tapping," it is said, "has of necessity to be of a few shoots per bush; therefore we have to grow these shoots at such a height and by such an arrangement that the labour can tap as many shoots as possible in the smallest area with the minimum of trouble."

The pamphlet gives full details of all the operations necessary to form a plantation and to exploit it, but emphasizes the fact that the methods at present employed are the results of, and therefore to some extent due to, the fact that during the past year it has been a 'rush-job'. From the descriptions given of the work it seems to be very satisfactory, and to reflect great credit on the careful research work which has enabled it to be carried out at so critical a time for the Allies' rubber resources.

## FLINT KNAPPING

To fashion a flint implement both knowledge of the tricks of the trade and skill in execution are required. Watching the flint knappers at Brandon can teach the student many a 'wrinkle', but any attempt to do likewise soon demonstrates the overriding importance of long and patient practice. The Pitt Rivers Museum authorities at Oxford have recently issued their first Occasional Paper on Technology, and it is entitled "The Manufacture of a Flint Arrowhead by Quartzite Hammer-stone"*. The author is Sir Francis Knowles and the work is plentifully illustrated. One can only regret that the writer had not the chance to collaborate in a more extensive work with M. Contier who, though he has, so far as I know, published nothing, is perhaps the most skilful maker of flint tools in existence.

M. Contier is, or was, an ornamental stonemason with a workshop in the outskirts of Paris; but he was also a pupil of Breuil in the typology of flint implements, and the combination has been very fruitful. It was he who showed that the single-faceted, highly inclined striking platform of the so-called Clacton technique involved the swinging of a nucleus against a stone anvil; while the right-angled platform of the Levallois implements could be produced by vertical blows on the nucleus with a hammer-stone. Again, it was Contier who discovered the possibilities of the 'wood technique': the striking of the core, held in the hand, with a baton of wood instead of with a hammer-stone, whereby flaking similar to that long recognized as characteristic of Acheulean tools can be produced. Actually, the use of the softer hammer partially resolves the phenomenon of percussion produced by a stone hammer into that of pressure. A dictum of Contier's used to run—the Chellean technique is that of the anvil, but Acheulean man held the flint core in his hand and hit it with a wooden baton. He also, like Dr. Leakey, had definite views as to how the various types of burins were made.

But Contier was essentially a craftsman. Sir Francis Knowles, though with a limited, definite objective, has given us the written word upon this subject of technique. He is concerned only with the manufacture of arrowheads, using a quartzite hammer-stone, not an iron hammer as do the knappers of Brandon. His paper is the book of words for doing this. He tells us how to choose the materials, how to hold and hit them, how to 'turn the edge' of the flake, etc. His instructions are indeed what a cook would call the 'recepe' for the production of a complicated and beautiful piece of craftsmanship. Very definitely papers of this kind have value; still far too little is known about the material flint and the various ways in which it can be fractured. Incidentally, anyone who has tried his hand at it will know the difficulty of describing in words

* Pitt Rivers Museum, University of Oxford. Occasional Papers on Technology, 1: The Manufacture of a Flint Arrow-head by Quartzite Hammer-stone. By Sir Francis Knowles. Pp. 38+6 plates. 5s.

knapping techniques and processes, and Sir Francis is to be congratulated that in the work under notice the reader, with only a very little concentration, will readily appreciate the way the author sets to work to make his specimens. M. C. BURKITT.

## GEOPHYSICS AND GEOMORPHOLOGY IN U.S.S.R.

THREE numbers of the *Bulletin de l'Académie des Sciences de l'URSS*, Série Géographique et Géophysique (Nos. 4–5, 1941; No. 2, 1943; No. 3, 1943), which have recently reached us, give some idea of the progress made in geophysics and geomorphology in U.S.S.R. For convenience the papers are grouped under four headings: (1) Atmosphere, (2) Hydrosphere, (3) Lithosphere, and (4) Climatology.

(1) *Atmosphere.* A. M. Obuhov (453; 1941) presents a mathematical study of the energy distribution in the spectrum of a turbulent flow; M. E. Schwez, in his first paper (467; 1941), gives a mathematical study of the vertical velocities in a moving air mass, and in the second paper (No. 2, 55; 1943), a mathematical study of the velocity of wind and the turbulent diffusion; S. L. Ponisovski (432; 1941) discusses the state of the *E*-layer of the ionosphere at twilight; A. J. Driving, A. V. Mironov, V. M. Morozov and I. A. Khvostikov, in their study of the polarization and absorption of light in natural fogs (No. 2, 70; 1943), have found a discrepancy between observation and theory which they propose to solve by postulating the presence of submicroscopical droplets.

(2) *Hydrosphere.* Mathematical treatment of turbulence is attempted by M. Millionshchikov (433; 1941), who discusses the turbulent heat conduction of sea water; by W. Stockmann (483; 1941), who discusses the horizontal components of velocity of sea currents; and by K. V. Shutilov (447; 1941). L. S. Leibenson (411; 1941) presents a mathematical treatment of the movements of gas-containing liquid in a porous medium.

(3) *Lithosphere.* Magnetic anomalies in the Moscow region are discussed by A. G. Kalashnikov (No. 2, 83; 1943), thermal anomalies in the earth's crust caused by strata and rock masses of different thermal conductivities are discussed by N. N. Korytnikova (No. 3, 115; 1943); a new method of measurement of temperature in salt mines is proposed by S. A. Kraskovsky (No. 3, 134; 1943); a mathematical study of the processes of freezing and thawing is given by S. S. Kovner (No. 3, 143; 1943); and V. V. Beloussov (No. 3, 147; 1943) outlines a new hypothesis of the development of the earth's crust as due to the migration of radioactive elements. J. A. Skvorzov (Nos. 4–5, 501; 1941) discusses the methods of geomorphological analysis and mapping; and V. V. Galitzky (No. 2, 89; 1943) gives an account of the geomorphology of the Kara-Tau region (north-west Tian-Shan).

(4) *Climatology.* The problem of the gradual rise of the temperature of the arctic regions is discussed by B. L. Dserdsejevsky (No. 2, 60; 1943) and the effectiveness of synoptical weather predictions is discussed by M. A. Omshansky (No. 3, 161; 1943).

All papers are provided with summaries, either in English or German, but some of these summaries are too brief to be of much value. S. I. TOMKEIEFF.

## FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

### Tuesday, November 14

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the CHEMICAL ENGINEERING GROUP, the AGRICULTURE GROUP, and the INSTITUTION OF CHEMICAL ENGINEERS) (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 2 p.m.—Conference on "Grass Drying" (Dr. S. J. Watson: "Grass Drying—Chemical Aspects"; Mr. A. Goldberg and Mr. A. C. Bartelli: "Grass Drying—Engineering Aspects"; Mr. D. Fairclough: "Grass Drying—The Farmer's Viewpoint").

CHADWICK LECTURE (at the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Mr. Guy Howard Humphreys: 'Some Modern Trends in Sanitary Engineering" (Bossom Gift Lecture).*

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 5.15 p.m.—Mr. Christopher F. C. Hawkes: "Prehistoric Britain", (ii) "The Later Prehistoric Centuries".

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, Strand, London, W.C.2), at 5.30 p.m.—Mr. J. N. Aldington: "Bright Light Sources".

INSTITUTION OF CIVIL ENGINEERS (ROAD ENGINEERING DIVISION) (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. A. H. D. Markwick: "The Basic Principles of Soil Compaction and their Application".

### Wednesday, November 15

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. L. Hartshorn: "High-Frequency Heating".

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 2.30 p.m.—Mr. B. F. Karthauser: 'The Development and Design of Shell Type Boilers".

BRITISH INSTITUTION OF RADIO ENGINEERS (NORTH-EASTERN SECTION) (at the Neville Hall, Westgate Road, Newcastle-upon-Tyne), at 6 p.m.—Mr. A. H. Hoult: "Theory of Rectification".

SOCIETY OF CHEMICAL INDUSTRY (FOOD GROUP) (joint meeting with the CARDIFF SECTION and the CARDIFF SECTION OF THE ROYAL INSTITUTE OF CHEMISTRY) (at the Newport Technical College, Clarence Place, Newport, Mon.), at 6.30 p.m.—Dr. E. B. Hughes: "Chemistry in the Kitchen".

SOCIETY OF CHEMICAL INDUSTRY (BIRMINGHAM SECTION) (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY) (in the Chamber of Commerce, New Street, Birmingham), at 6.30 p.m.—Mr. C. W. Bonniksen: "Some Properties and Applications of Alginic Acids and Alginates".

### Thursday, November 16

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. G. M. Phillips, Mr. J. S. Hunter and Mr. L. E. Sutton: "Investigation of the Occurrence of the Co-ordinate or Dative Link by Electric Dipole Moment Measurements"; Mrs. G. A. Gilbert, Mr. F. Smith and Mr. M. Stacey: "A Constitutional Synthesis of Cellobiose and Gentiobiose".

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 2.30 p.m.—Sir James Jeans, O.M., F.R.S.: "Old and New Descriptions of the Astronomical Universe", (iii) "Galaxies".

ROYAL SOCIETY OF ARTS (INDIA AND BURMA SECTION) (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. R. Maclagan Gorrie: "The Place of Mechanized Equipment in Indian Soil Conservation".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 3 p.m.—Prof. S. Mandelbrojt: "On the Regularization of Sequences".

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Harold Hartley, F.R.S.: "Antoine Laurent Lavoisier" (Lavoisier Bicentenary Lecture).

CHEMICAL SOCIETY (in the Department of Chemistry, University College of North Wales, Bangor), at 5.30 p.m.—Prof. R. D. Haworth, F.R.S.: "Oxidation of Phenols".

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 8 p.m.—Symposium on "Physical, Biochemical and Therapeutic Aspects of Volume Dose".

### Friday, November 17

SOCIETY OF CHEMICAL INDUSTRY (PLASTICS GROUP) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Discussion on "Polymer-Plasticiser Interaction" (to be opened by Dr. R. F. Tuckett and Miss E. M. Frith).

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 5 p.m.—Vice-Admiral Sir John A. Edgell, K.B.E., F.R.S.: "Ocean Passages, Depths and Currents—the Work of the Hydrographic Department in Peace and War".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. H. E. Wimperis: "Research and Development in Aeronautics" (Thirty-first Thomas Hawksley Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. G. E. Moore: "Planning the Future Electricity Meter".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Mr. J. S. Thompson: "In Search of Efficiency".

CHEMICAL SOCIETY (in the Royal Technical College, Glasgow), at 7.15 p.m.—Mr. R. P. Bell, F.R.S.: "The Value of the Resonance Concept in Chemistry".

### Saturday, November 18

QUEKETT MICROSCOPICAL SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Papers.

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield, 1), at 2.30 p.m.—Mr. R. A. Hacking: "Technical and Economic Problems in the Heavy Iron and Steel Industry".

## APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (full-time) in the Ashington Mining School (applicants should possess a Degree in Physics or General Science and be prepared to take MATHEMATICS to School Certificate standard)—The Director of Education, County Hall, Newcastle-upon-Tyne 1 (November 15).

GRADUATE LECTURER (full-time) IN MATHEMATICS in the Medway Technical College, Gillingham—The District Education Officer, Fort Pitt House, Rochester (November 16).

LECTURER (full-time) IN MECHANICAL ENGINEERING in the Schools of Technology, Art and Commerce, Oxford—The Chief Education Officer, City Education Office, 77 George Street, Oxford (November 17).

SPEECH THERAPIST (full-time) to undertake duties in the areas of the Bridgwater, Taunton and Yeovil Education Committees—The Clerk to the Taunton Borough Education Committee, Education Office, Municipal Buildings, Taunton (November 18).

AGRICULTURAL TRAINING OFFICER to organize the scheme for the training in Agriculture and Horticulture of men and women released from War service—The Chief Executive Officer, Herefordshire War Agricultural Executive Committee, 4 St. John Street, Hereford (November 20).

HEAD OF THE ENGINEERING DEPARTMENT—The Principal, Stockport College for Further Education, Stockport (November 20).

LECTURER IN BIOLOGY, with Botany or Physiology as subsidiary subject—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham (November 20).

LECTURER IN GEOGRAPHY—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (November 22).

LECTURER (man or woman) IN MATHEMATICS—The Registrar, University College, Southampton (December 1).

ASSISTANT (temporary) IN THE DEPARTMENT OF ZOOLOGY—The Deputy Director, Museum and Art Gallery, Bristol 8 (December 9).

ENGINEERS by the Government of Nigeria for the Posts and Telegraphs Department—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.971.A) (December 11).

DIRECTOR OF RESEARCH—The Secretary, British Internal Combustion Engine Research Association, 111–112 Buckingham Avenue, Slough, Bucks. (December 31).

LECTURER IN EXPERIMENTAL ZOOLOGY—The Registrar, The University, Liverpool (January 5).

DIRECTOR—The President, British Coal Utilisation Research Association, 13 Grosvenor Gardens, London, S.W.1 (January 31).

MASTER FOR ENGINEERING SUBJECTS, including Workshop Practice—The Principal, Erith Technical College, Belvedere, Kent.

TEACHER FOR PHYSICS AND CHEMISTRY—The Acting Principal, Technical Institute, Sheerness.

GRADUATE ASSISTANT (temporary) to teach chiefly PHYSICS and MATHEMATICS in the Thomas Richards Technical Institute, Tredegar—The Acting Director of Education, Higher Education Department, County Hall, Newport, Mon.

SPEECH THERAPIST—The Director of Education, Shire Hall, Nottingham.

BOTANIST (male) IN THE BRANCH OF PLANT PATHOLOGY AND BOTANY of the Department of Agriculture, Southern Rhodesia—The Official Secretary, Rhodesia House, 49 Strand, London, W.C.2.

## REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

Geological Survey of Great Britain. Wartime Pamphlet No. 13: Limestones of Scotland. Area 5: Central Grampians. By Dr. J. G. C. Anderson; with Analyses by H. G. M. Hardie. Second edition. Pp. 20. 1s. Area 6: Banffshire and the North-East Grampians. By Dr. J. G. C. Anderson; with Analyses by Dr. A. Muir. Second edition. Pp. 22. 1s. 3d. (London: Geological Survey and Museum.) [139

Health Abounding: the Social Credit National Health Service; an Outline. By Aubrey T. Westlake. Second edition, revised and enlarged. Pp. 52. (London: Social Credit Party.) 1s. [159

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences). Vol. 62, Part 1, No. 9: On the Line-Geometry of the Riemann Tensor. By H. S. Ruse. Pp. 64–73. 1s. 6d. Vol. 62, Part 1, No. 10: The Factorial Analysis of Multiple Item Tests. By D. N. Lawley. Pp. 74–82. 1s. 6d. Vol. 62, Part 1, No. 11: The Identification of Klein's Quartic. By Dr. W. L. Edge. Pp. 83–91. 1s. 6d. (Edinburgh and London: Oliver and Boyd.) [189

Ministry of Home Security. F.G. Leaflet No. 19: Methods of Reducing the Fire Risk in Fibre Building Boards in Wartime Building. Pp. 8. (London: Ministry of Home Security.) [199

Motherhood in the Post-War World. An Address by Dr. Grantly Dick Read. (Published for the Council of Seven Beliefs.) Pp. ii+20. (London: William Heinemann (Medical Books), Ltd.) 6d. net. [209

Institute of Welding: Welding Research Council. Recommended Technique for making Fillet Welds in the Downhand, Vertical and Overhead Positions. (T. 13.) Pp. 8. (London: Institute of Welding.) [219

National Trust for Places of Historic Interest or Natural Beauty. Report of the Council for the Years 1943–1944. Pp. 62+8 plates. (London: National Trust.) [219

The Heather Beetle (*Lochmea suturalis*): an Enquiry into its Biology and Control. Made on behalf of the British Field Sports Society by Dr. A. E. Cameron, J. W. McHardy and Dr. A. H. Bennett. Pp. 69+13 plates. (Petworth: British Field Sports Society.) 1s. [229

The Church and the Planning of Britain. Report of the Social and Industrial Commission of the Church Assembly, 1944. (C.A. 753.) Pp. 32. (London: Church Assembly.) 2s. [259

British Astronomical Association: its Nature, Aims and Methods. Pp. 34. (London: British Astronomical Association.) 3s. [259

British Council. Report for 1943–1944. Pp. 138+12 plates. (London: British Council.) [279

Social Insurance. Part 1. (Cmd. 6550.) Pp. 64. (London: H.M. Stationery Office.) 6d. net. [279

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences). Vol. 62, Part 1, No. 12: Quantum Mechanics of Fields, 2, Statistics of Pure Fields. By Prof. Max Born and Dr. H. W. Peng. Pp. 92–102. 2s. Vol. 62, Part 1, No. 13: A Problem in the Random Distribution of Particles. By Dr. William Ogilvie Kermack. Pp. 103–115. 2s. 3d. (Edinburgh and London: Oliver and Boyd.) [289

### Other Countries

University of Illinois: Engineering Experiment Station. Bulletin No. 350: Fatigue Strength of Fillet-Weld and Plug-Weld Connections in Steel Structural Members. By Wilbur M. Wilson, Walter H. Bruckner, John E. Duberg and Howard C. Beede. Pp. 94. 1 dollar. Bulletin No. 351: Temperature Drop in Ducts for Forced-Air Heating Systems. By Alonzo P. Kratz, Seichi Konzo and Richard B. Engdahl. Pp. 60. 65 cents. Reprint No. 28: Tenth Progress Report of the Joint Investigation of Fissures in Railroad Rails. By Ralph E. Cramer and Russell S. Jensen. Pp. 24. 15 cents. Reprint No. 29: Second Progress Report of the Investigation of Shelly Spots in Railroad Rails. By Ralph E. Cramer. Pp. 10. 15 cents. Reprint No. 30: Second Progress Report of the Investigation of Fatigue Failures in Rail Joint Bars. By Norville J. Alleman. Pp. 12. 15 cents. Reprint No. 31: Principles of Heat Treating Steel. By Prof. Harold L. Walker. Pp. 46. 15 cents. (Urbana, Ill.: University of Illinois Engineering Experiment Station.) [178

Kungl. Svenska Vetenskapsakademiens Handlingar. Serien 3, Band 20, No. 11: An Improved Photographic Method for the Quantitative Study of the Reflexion of X-Rays by Crystals. By J. A. Wasastjerna. Pp. 26+17 plates. Serien 3, Band 20, No. 12: On the Apparent Distributions and Properties of Triple and Multiple Stars. By Åke Wallenquist. Pp. 33. Serien 3, Band 20, No. 13: Die Hydracarinenfauna Sudbrasiliens und Paraguays. Von O. Lundblad. Teil 5. Pp. 182+10 plates. Serien 3, Band 21, No. 1: On the Morphology of the Lower Jaw of Stegocephalia with special reference to Eotriassic Stegocephalians from Spitsbergen. 2: General Part. By Tage Nilsson. Pp. 70. (Stockholm: Almquist and Wiksells Boktryckeri A.-B.) [218

Proceedings of the American Philosophical Society. Vol. 88, No. 1 (June 16, 1944): Symposium on Taxation and the Social Structure. Papers read before the American Philosophical Society, Midwinter Meeting, February 18–19, 1944. Pp. iii+70. (Philadelphia: American Philosophical Society.) [228

Smithsonian Miscellaneous Collections. Vol. 104, No. 4: The Influence of Light and of Carbon Dioxide on the Respiration of Etiolated Barley Seedlings. By Robert L. Weintraub and Earl S. Johnston. (Publication 3769.) Pp. ii+16+2 plates. Vol. 104, No. 5: Weather Predetermined by Solar Variation. By C. G. Abbot. (Publication 3771.) Pp. ii+44. Vol. 104, No. 6: Smithsonian Pyrheliometry and the Andean Volcanic Eruptions of April 1932. By L. B. Aldrich. (Publication 3772.) Pp. ii+6. (Washington, D.C.: Smithsonian Institution.) [228

U.S. Department of Agriculture. Circular No. 697: Laboratory Studies on the Toxicity of Tartar Emetic to the Mexican Fruitfly. By C. C. Plummer. Pp. 14. (Washington, D.C.: Government Printing Office.) [258

Herbertia. Vol. 10, Tenth Anniversary edition. Edited by Hamilton P. Traub. Pp. 198. (Salinas, Calif.: American Amaryllis Society.) [298

Associação Portuguesa para o progresso das Ciências. O Contributo dos descobrimentos dos Espanhóis e Portugueses nos séculos XV e XVI para o conhecimento científico do Homem e das raças humanas. Por Prof. A. A. Mendes Corrêa. Pp. 19. (Pôrto: Imprensa Portuguesa.) [298

U.S. Department of Agriculture. Technical Bulletin No. 871: *Aspanteles diatraeae*, a Braconid Parasite of the Southwestern Corn Borer. By E. G. Davis. Pp. 20. (Washington, D.C.: Government Printing Office.) [298

Publications of the Observatory of the University of Michigan. Vol. 9, No. 1: Fifth List of New Southern Double Stars found at the Lamont-Hussey Observatory of the University of Michigan at Bloemfontein, South Africa. By Richard A. Rossiter. Pp. 6. (Ann Arbor, Mich.: University of Michigan.) [308

Papers of the Michigan Academy of Science, Art and Letters. Editors: Eugene S. McCartney and William C. Steere. Vol. 28 (1942). Pp. xiii+701+52 plates. (Ann Arbor, Mich.: University of Michigan Press; London: Oxford University Press.) 28s. net. [49

Ontario Research Foundation. Report for the Year 1943. Pp. 28. (Toronto: Ontario Research Foundation.) [49

### Catalogues

Old Medicine: Art in Medicine, Renaissance Medicine—Instruments. (Catalogue 5.) Pp. 40. (London: E. Weil.)

The 'Pyrobit' Tester. Pp. 2. (Manchester: The Acru Electric Tool Manufacturing Co., Ltd.)

Light's Organic Chemicals. Pp. 14. (Wraysbury: L. Light and Co., Ltd.)

Additional German Publications being reproduced in America by the photo-offset process under authorization of the Alien Property Custodian in Washington. Pp. 8. (London: H. K. Lewis and Co., Ltd.)

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## CONTENTS




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# A COLLEGE OF AERONAUTICS

AN Interdepartmental Committee on the Establishment of a School of Aeronautical Science was set up in October 1943, under the chairmanship of Sir A. H. Roy Fedden, who had just returned from a mission to the United States, where he had studied, among other matters, the system of aeronautical education in that country. The members of the committee dealing with the scheme were Sir A. H. Roy Fedden (chairman); Sir Alan Barlow, Treasury; Commdr. M. S. Slattery, Admiralty; Mr. W. P. Hildred, Air Ministry; Air Marshal Sir Ralph Sorley, Ministry of Aircraft Production; Sir John Stephenson, Dominions Office; Dr. W. Abbott, Ministry of Education; Sir Charles Darwin, Department of Scientific and Industrial Research; Sir B. Melvill Jones, Aeronautical Research Committee; and Sir Walter Moberly, University Grants Committee. Detailed memoranda and oral evidence were given by representatives of the various interests concerned, a list of which is added to the report*.

The Committee's report states that the object of the suggested college should be to provide a high-grade engineering, technical and scientific training in aeronautics for selected students to fit them for leadership in the aircraft industry, civil aviation, the Services, and for education and research. Sir Stafford Cripps, Minister of Aircraft Production, has already stated, in the House of Commons, that the Government accepts the report in principle and that the Air Ministry is making temporary accommodation available. It is understood that this is to be at Abingdon Aerodrome, Oxfordshire. The cost of this adaptation is likely to be about £150,000, with an additional £300,000 for equipment. The complete scheme, which it is suggested should be situated at either Aldermaston in Berkshire or Dunsfold in Surrey, will cost £2,610,000, with an annual upkeep of £380,000. About £150,000 would also be needed for removing and adapting apparatus from the temporary to the permanent site, and this must be regarded as an expenditure justified by the urgency of the need for starting the scheme at once.

While the efficient use of any applied science by industry must depend upon a continuous flow of scientifically trained entrants, the aeronautical world makes an even greater demand in that its new men need a more comprehensive training. They must be scientific men first, probably either physicists or engineers, and then be further trained in the technology of the application of their science to aeronautics. This is particularly true of engineering, where many problems arise that are peculiar to aircraft and aero-engine design and construction. Education has its own need as well. Facilities for obtaining the more elementary and technological training need to be much more widely spread over the country than they are at present. Such courses will be able to give the shorter theoretical and more practical training to those needing only this, in their own localities, and

* Ministry of Aircraft Production. A College of Aeronautics: Report of the Interdepartmental Committee on the Establishment of a School of Aeronautical Science. Pp. ii+98. (London: H.M. Stationery Office, 1944.) 2s. net.

will also provide a suitable flow of candidates to the proposed college, as well as to the universities. The Ministry of Education is already preparing plans for such courses in many of the local technical colleges and institutions, under extensions of the National Certificate scheme, and some of the universities are considering the question of undergraduate courses in aeronautics and aeronautical engineering.

Many of the Dominions, India, and the Colonies are moving in this matter, and it would serve a double purpose if they also encouraged their students to attend a central establishment in Britain for the completion of their training. All such schemes will form a reservoir from which the best men can be drawn to proceed to a higher education such as this college will provide.

The report also says: "We believe that progress will now depend less on the genius and resource of individuals and more on the organized investigation and experimentation of trained workers working in teams and using large-scale equipment. If so, then the College is essential to the future of the industry." This postulates a further outlook for such a scheme. It will train research workers and produce results of a kind that will be different from, and will not in any way trespass upon the province of, the accepted type of research establishment.

Another aspect that has never received sufficient attention in the past is the more scientific aspect of flight and flying operations. Such problems have come within the province of the Fighting Forces up to the present, and have presumably been investigated by them within their own organizations. The coming of long-distance transport, with its possibilities of stratosphere operation, bring problems for the physicist, engineer, flying operator and the pilot that can only be properly solved by teams of workers, some of whom are pilots trained in the more scientific aspects of flight, working in an atmosphere of experimentation such as would be found in a college of the kind proposed.

The principal function of this college will be to provide a two-year advanced training in aeronautics for about fifty students. It is suggested that they should be of university graduate standard, with at least one year of works experience, although it is emphasized that the possession of a degree should not be considered to be essential.

Shorter courses of a more specialized nature, either to provide training for administrators who do not require complete technical knowledge, or as refreshers for men already engaged in the profession, are contemplated, up to the numbers of a further two hundred students.

The syllabus will contain five main subjects: aerodynamics; aircraft structures, engineering and design; aircraft equipment; engines and systems of propulsion; production, administration and maintenance. Flight and operations will be included, embracing full-scale experimental work and flight testing.

The teaching and experimental work will be in the hands of a professor with a suitable permanent staff in each of the five branches. Specialist subjects can best be dealt with in short courses by visiting lecturers, who are engaged on that work professionally, possibly with the assistance of some of the permanent staff from the point of view of the technique of teaching. The short courses will obviously be principally of this class of lecture, while the full two-year course will have more of the fundamental science type of teaching, with a judicious mixture of specialist work. It is hoped to combine some appropriate experience in flying and flight conditions with all the courses. The establishment will naturally be in the hands of a principal with the necessary administrative staff; advised by a governing body representing the aircraft industry, the universities, the Government and Service departments, the Dominions and the Royal Aeronautical Society.

The report suggests that the college should be placed under the Ministry of Education for administration purposes, which would be given a special vote for its expenditures. It is also hoped that a Royal Charter would be granted.

The equipment of such a school will be large and expensive, and will need careful thinking out if it is not to lose its usefulness through obsolescence in a comparatively short time. It will need to be chosen to illustrate basic principles rather than to compete in modernity with the latest equipment of a professional research establishment. For example, wind-tunnels, which would inevitably be the principal equipment of the aerodynamics section, always tend towards greater 'Reynolds' number', which is obtained by a combination of increases in size, wind-speed and internal pressure. All these inevitably add to the complication of the apparatus, the rate at which experiments can be carried out and the cost. It is more than likely that all these points would make a high Reynolds' number tunnel unsuitable for demonstrating the principles of aerodynamics to students. The measurement of a force by the simple counterpoising of it by a weight is so much more obvious than, say, balancing it by an electric solenoid where the reading merely becomes a figure on the dial of a measuring instrument. The report suggests a battery of smaller tunnels, and one of higher speed for the more advanced work appropriate to the college.

For aircraft design the equipment will be mostly testing machines and rigs for the investigation of strengths of structural components. It is recommended that one slow-speed general-purpose wind tunnel be provided here, of sufficient size to accommodate full-size aircraft parts. The provision of this will avoid interference with the programme of work in the aerodynamics section. Aircraft equipment will probably need a multitude of small items appropriate to the testing and development of instruments, electrical, and electronic work in general.

Engines and systems of propulsion will demand a good deal of equipment to cover the work. Reciprocating engines will need facilities for tests on both single-cylinder research units and complete engines up to the largest sizes. Gas turbines must also be investigated, although in the present state of knowledge of these it is difficult to foresee just what equipment may ultimately be necessary. Test rigs will be needed for problems in the development of super-charging,

carburation, ducting, propellers, accessories, and for tests on fuels and oils.

'Production and materials' will need typical workshops sufficiently equipped for students to fabricate such parts as they may be investigating, a standards room and an inspection department. The metallurgical outlook, both practical and theoretical, will need special equipment covering chemistry, metallography, crystallography and plastics.

'Flight and operations' will obviously call for an aerodrome with the usual facilities, and a fleet of aircraft of various types. Using aircraft as flying laboratories requires a very well-equipped maintenance workshop with the right type of personnel, and a comparatively large fleet of machines to ensure continuity of demonstration.

In putting forward this scheme, the aeronautical world has given a lead that might well be followed by many industries that make use of applied scientific and technical knowledge. It is becoming increasingly evident to-day that there is a distinct gap between the end of a scientific university type of training, and a correspondingly responsible position in the appropriate profession. Some postgraduate training is necessary, of an advanced technical nature, rather different from the specialized research which is the only work the universities offer at present to postgraduate students. It is obvious that such training can best be given in a school, properly equipped and staffed by teachers who are specialists both in education and the appropriate professional work. Such students need to take the telescopic rather than the microscopic view of their technology. It is not too much to hope that this school will prove to be the forerunner of many others in various industries.

It is a pity that no situation nearer the centre of London could have been found. The technology of aeronautics is so closely related to the various societies which are all established in the heart of London that a situation within say the orbit of 'London Transport' would have seemed almost a necessity. There are still one or two large R.A.F. aerodromes within this range that will surely be made redundant in peace-time by the increasing speed and range of modern service aircraft.

Probably the greatest difficulty that the Ministry of Education will meet in the administration of this college will be to find the necessary teaching staff. It must be realized, as is appreciated by all educationists, that there is something in the art of teaching, and that the man who may be an acknowledged expert on his subject is not necessarily the best to impart that knowledge to a class of students. The reservoir from which such men can be drawn at present must be extremely limited.

The Government has shown considerable courage in embarking upon this scheme at a time when the ending of the War must create a period of uncertainty in the aircraft industry. It is to be hoped that those who control the world of aircraft and aero-engine design and construction will find themselves able to take as long a vision, and provide employment for such students, with both duties and salary in keeping with the training that they have undertaken.

# PROGRESS OF PLANT VIRUS RESEARCH

## Plant Viruses and Virus Diseases

By F. C. Bawden. (A New Series of Plant Science Books, Vol. 13.) Second entirely revised edition. Pp. xiv+294. (Waltham, Mass.: Chronica Botanica Company; London: Wm. Dawson and Sons, Ltd., 1943.) 4.75 dollars.

It is just over half a century since the discovery of the first virus, that of tobacco mosaic, and it is perhaps fitting that during the last ten years it is the study of this virus which has yielded such fruitful results. There are, however, some outstanding questions which need to be answered concerning viruses and particularly plant viruses. First and foremost perhaps, as suggested by Mr. Bawden, there is the behaviour of viruses in their natural environment, the cells of the host. In other words, how do viruses multiply? This aspect may, as the author hopes, provide the next great advances in knowledge of the subject. Let us hope so too, but it is such a fundamental study that one cannot see at present just how it is to be tackled.

Then there is the puzzling subject of the relationship between viruses and insects, very clearly and succinctly discussed in this book. Is there really an intimate relationship between the two, and do plant viruses actually multiply inside their insect vectors? Or is the whole question merely one of particular feeding methods whereby the virus is introduced into the right plant tissues, and of particular anatomical conditions in the insect which must be fulfilled to permit of adequate virus storage? All these questions need answering, and although we have a mass of data concerning insects and plant viruses, we really know very little about their relationships.

Then take the question of the origin of viruses dealt with in Chapter 16. The author cites the paracrinkle virus present in all King Edward potatoes, also recently discussed in *Nature*[1], and suggests that it is possible that viruses may have arisen, only to disappear with the death of their host plant. Presumably, however, if such viruses can be transmitted by insects, they would be spread to other plants and a new virus disease would be perpetuated. Unfortunately, or perhaps fortunately, so many of the new viruses which do come to light are not apparently insect-borne.

There is no doubt that previously undescribed viruses do appear in plants, even under controlled conditions, and these would undoubtedly have been lost again if they had not been carefully propagated by artificial means. There is the interesting case of tomato bushy stunt virus, which suddenly appeared in a few tomatoes in the Bristol area and one or two other localities in 1935 and then disappeared again completely until the summer of this year, when it was re-discovered affecting tomatoes near Worcester. No insect vector has ever been discovered for this virus nor has it been found occurring naturally in any other host plant. Incidentally, this virus was first purified as true three-dimensional crystals by the author and N. W. Pirie, and the purification of viruses and the properties of purified virus preparations are well discussed in Chapters 8, 9 and 10.

The author has made a special study of the serological reactions of plant viruses, and he discusses this aspect very thoroughly in Chapter 7. He also advocates in Chapter 14 a classification of plant

viruses based on their serological relationships, in a severely critical review of present systems of nomenclature and arrangement. Undoubtedly a classification of viruses based on some such scientific basis as serological relationships would be ideal. Unfortunately the fact that a very large number of viruses cannot at present be studied by serological methods renders such a classification for the time being purely academic.

Mr. Bawden is to be congratulated on a very good book which presents an authoritative survey of the present status of plant virus research.

KENNETH M. SMITH.

[1] *Nature*, **154**, 164, 334 (1944).

## INORGANIC NUTRITION OF PLANTS

**Lectures on the Inorganic Nutrition of Plants**
(Prather Lectures at Harvard University.) By Prof. D. R. Hoagland. (A New Series of Plant Science Books, Vol. 14.) Pp. xii+226 (28 plates). (Waltham, Mass.: Chronica Botanica Company; London: Wm. Dawson and Sons, Ltd., 1944.) 4 dollars.

THE present volume embodies the texts of seven lectures, five of which were originally delivered at Harvard University under the Prather Lectureship. It is fortunate that these lectures have been printed, for this is undoubtedly a valuable contribution to the literature of the subject. It carries, of course, the limitation of the form of presentation. Prof. Hoagland explains in the preface that "this small volume cannot have any of the characteristics of a monograph or a text"—and such it has not. But it does provide a discursive survey of a field of investigation in which cohesion is frequently obscured by the rich variety of topics that the subject is commonly held to embrace, and in which, therefore, such a survey is particularly valuable.

The variety of content probably makes the subject difficult to discuss comprehensively, and to this, no doubt, must be attributed the fragmentary character of the discussion. But the difficulty is not relieved by the particularly generous view that the author takes of the implications of the term 'inorganic nutrition of plants'. The book begins with a discussion of soil conditions in relation to nutrient absorption, deals then with micronutrient elements, the absorption and accumulation of salts by plant cells, the translocation of inorganic solutes, exudation and root pressure, the growth of plants in artificial media, the relation of salt absorption to organic acids, and concludes with a chapter on potassium nutrition. In different connexions extensive reference is made both to the crystalline structure of soil colloids and to the synthesis of amino-acids. Inevitably within a text which is restricted to a hundred and eighty small pages of comparatively large print, the treatment of even the majority of these topics cannot be extensive, and must, in many instances, be unduly cursory. Moreover, in certain connexions the emphasis is unusual. The metabolic significance of potassium, nitrogen and zinc receives considerable attention, but there is little discussion of, for example, phosphate nutrition; and whereas the effects of individual elements are described, the interaction of the several nutrients in metabolism and growth is not treated in any detail.

These criticisms, however, are in any event not important, and may be irrelevant, since Prof. Hoagland writes: "the assumption was made that in lectures of the present type and objective the writer should emphasize the work with which he has had most direct contact". That work represents a distinguished body of contributions, and the prominence that it receives necessarily emphasizes certain recent important developments both in the elucidation of the mechanisms of well-recognized phenomena, and in the elaboration of new techniques. The author and his school have devoted considerable attention to the processes of salt absorption, accumulation and translocation, and in relation to these the importance of the metabolic situation is developed in some detail; the particular implications of absorption from the soil are discussed; and valuable summaries are provided of the results of investigations based on the use of radioactive isotopes as tracers.

The text is adequately illustrated with figures and plates; it is also supplied with a number of tables which are difficult to decipher, the print and numerals being distressingly minute. Otherwise the print and lay-out are admirable.

R. BROWN.

## LOCAL GOVERNMENT FINANCE

**The Problem of Valuation for Rating**
By J. R. Hicks, U. K. Hicks and C. E. V. Leser. (National Institute of Economic and Social Research, Occasional Papers No. 7.) Pp. vii+96. (Cambridge: At the University Press, 1944.) 7*s*. 6*d*. net.

THIS paper is the second part of a study of the incidence and effects of local government taxation, the first part of which, "Standards of Local Expenditure", has already appeared and the third of which will round off and complete a work of great interest and considerable importance for those who are, or shall be, occupied in local planning and reconstruction. It may well be the most significant of the three; for it examines and discusses the key problem of local finance—the variation in the burden of rates from one area to another due to the absence of uniformity in the standards employed for valuing rateable property. It is an old problem, the essentials of which were being studied by a Departmental Committee on Valuation for Rating set up in 1938 which had not completed its task at the outbreak of war. The authors were fortunate in having been permitted access to returns collected for the use of this Committee. They are, in consequence, able to offer reliable evidence confirming conclusions hitherto based on surmise or impression only.

Briefly, the conclusions are that rating valuations are inaccurate, that, therefore, they are not an index of the true wealth of an area, and the anomalies resulting from this stand in the way of effective assistance by means of grants to the poorer areas. As at present administered, rates are a bad tax. On the other hand, their abolition and replacement by an alternative would involve a fundamental alteration in the whole basis of local government. This is not practical; but some measure of reform is imperative, and a beginning might be made with the regularization of the assessment of rateable values. It is generally understood that the Rating and Valuation Act of 1925 had this, among other aims, in view; but the uniformity in valuation practice which was anticipated was not realized. In 1938,

thirteen years later, the condition in this respect could only be described as chaotic. The remedy suggested is the transference of the responsibility for valuation to a central authority which, helped by a court of appeal, would in the course of time evolve a national code of rules. The authors proceed to examine the difficulties that would arise in any attempt at speedy reassessment from the fact that, under the present law, rates vary nearly proportionately with gross values and that, to prevent them from falling on the poor to an extent felt to be intolerable, there is under-assessment of 'poor' houses in comparison with 'wealthy' houses. There is also the problem arising from the prevalent tendency to value new houses at a relatively lower level than old houses. Much time would elapse before the proposed new authority could straighten out imperfections; for a new system must grow slowly.

It was not part of the authors' plan to suggest major innovations or reforms in the finance of English local government. This is to be regretted; for it is no secret that small and poor authorities are viewing with dismay the addition to the commitments threatened or imposed upon them by the new Education Act and similar measures. Rumour has it that only minor alterations in boundaries will be made as the result of government inquiries now proceeding and that the larger and wealthy areas will be left substantially untouched. It is difficult to escape the conclusion that the size and functions of local government units call for drastic revision if the present financial system is to continue.

J. G. SMITH.

## FLUORESCENCE AND PHOSPHORESCENCE AND THEIR APPLICATIONS

### Luminescence of Liquids and Solids

And its Practical Applications. By Peter Pringsheim and Marcel Vogel. Pp. x+201. (New York: Interscience Publishers, Inc.; London: Imperia Book Co., Ltd., 1943.) 4 dollars.

THE study of luminescence, particularly the luminescence of solids, has undergone profound changes during the last ten years. Before that time, knowledge of energy states and energy transfers in the liquid and solid states was exceedingly meagre; the subject of luminescence as a whole had a very uncertain theoretical basis. The recent advances have perhaps been more striking in the case of solids, and this can be traced in great part to the stimulation which the subject received from A. H. Wilson's papers on semi-conductors. Almost simultaneously, some of the newer discharge lamps began to pass from the laboratory to the manufacturing stage. The new mercury discharge lamps were at once a challenge to those interested in the luminescence of solids; for the emission spectrum of these lamps contained a plentiful proportion of near ultra-violet radiation, coupled with a deficiency of emission at the red end of the spectrum. Lamp manufacturers in many parts of the world successfully met this challenge, and greatly improved techniques for the preparation of luminescent solids were developed, with results that most of us are now familiar with. At the same time the more fundamental aspects of the subject received renewed attention (see, for example, the Faraday Society's Discussion on Luminescence, 1938), and it was clear that the subject was emerging from a period of empirical research previously dominated by the Lenard school, and documented, for example, in vol. 23 of the "Handbuch der Experimental Physik".

Prof. Pringsheim is well known for his original work on the fluorescence of liquids and vapours, and also for his earlier book "Fluorescenz und Phosphorescenz", the third edition of which was published in 1928. This book undoubtedly gave the best available physical approach to the subject, but from the modern point of view it was sadly out of date, and scarcely comprehensive. The present reviewer had hoped that the new work by Pringsheim and Vogel would in effect be a completely revised edition of the earlier German monograph. In this it must be confessed he is disappointed; the new volume is a popular exposition of the subject, and particular emphasis is laid on the applications. Within these self-imposed limits, the authors have produced a useful survey for the general reader; it cannot be said that the book will add much to the knowledge of specialists.

The first part of the book is concerned with the physics of luminescence. After a brief introduction to the historical and theoretical aspects of the subject, experimental technique, materials and their properties are considered at length. A chapter is also devoted to the rapidly growing subject of fluorescence analysis. Fluorescent paints and screens for various purposes are also considered, but some of the later illustrations are more reminiscent of the cheaper type of commercial brochure than would have been anticipated from the hands of the senior author. Figs. 56, 57 and 59 give, respectively, external views of a cathode-ray tube, a television receiver and an electron microscope; they do not appear to serve any particularly useful purpose.

It is to be hoped that Prof. Pringsheim will now write the book we have been waiting for.

J. T. RANDALL.

## GERMANO-POLISH PROBLEMS

### Teuton and Slav on the Polish Frontier

A Diagnosis of the Racial Basis of the Germano-Polish Borderlands and Suggestions for the Settlement of German and Slav Claims. By Lt.-Col. G. R. Gayre. Pp. 76+18 plates and 41 maps. (London: Eyre and Spottiswoode (Publishers), Ltd., 1944.) 8*s.* 6*d.* net.

LIEUTENANT-COLONEL GAYRE has written a short study of the Germano-Polish problem in terms of physical and social anthropology. He has sought indeed to give as much information, explanation and comment by means of cartography as through the letterpress, since the book has more than forty maps and diagrams.

Some of the cartographical material is interesting in that the work of foreign scholars has been reproduced for the benefit of English readers for the first time. Some maps, however, are spoiled by the form of reproduction, for example, Nos. 4, 5, 16 and 31, in which the type of the place-names and legend has been reduced so much that the result is illegibility.

The descriptions of geographical background, of the physical characteristics of the peoples concerned, and of their culture, are not without interest, nor

are the final comments on possible post-war frontiers. But the reader who has had the opportunity of studying the Germano-Polish question is left at the end with a feeling of disquiet. He has the impression that factual information has been chosen to make yet another theory on the vexed problem of Central Europe, but that even an outline tale has not been told in proportion. Any account of the Germano-Polish settlement areas, for example, should contain much more emphatic comment upon the loess strip between the Hercynian Highlands and the glacial plain than is present in Lieutenant-Colonel Gayre's study. Moreover, the story of Teuton-Slav relations is incomplete from the point of view of the anthropologist without some treatment of the migrations of the Dark Ages. It is misleading to take it up at the stage when the peoples of Central and Western Europe were beginning to achieve some geographical fixity, especially when early history is made the foundation of political opinion on current events. Finally, although one may agree with the author that too great an importance was attached to linguistic divisions in the re-drawing of frontiers after the War of 1914–18, it is difficult to believe that physical anthropology is going to prove a safe guide to demarcation after the present one.

Lieutenant-Colonel Gayre makes a point at the end of his study which is worth close attention. Before the first World War the disparity between the German and Polish birth-rates was noticeable, and the greater increase of the Slavs has continued between the two Wars. The Germans may have needed *Lebensraum* in the sense of greater economic opportunity, but they wanted living space in the literal sense much less urgently than the Poles. The eager concentration of the Germans on penetration into Eastern Europe came rather from demographic unease, an instinctive dread of the multiplying Slavs, than from territorial need. The immense loss of German man-power in the present War suggests that pressure on living space in Germany will be still less, once the actual devastation of war is repaired. It remains to be seen whether the terrible destruction of life and material well-being in Poland will affect the demography of that country only temporarily or permanently.

It is scarcely the fault of the author if the development of the 'art' of war in the fifth year of this struggle makes arguments on frontier demarcation from the strategic point of view seem a little irrelevant.
H. G. STEERS.

# ELEMENTARY ZOOLOGY

## Animal Biology

By Dr. A. J. Grove and Dr. G. E. Newell. Second edition. Pp. viii+678. (London: University Tutorial Press, Ltd., 1944.) 16*s*.

THIS book is already well known, and young people coming to the study of zoology for the first time will find in this second edition an account of animal structure which is welded with the elementary facts about the animal's physiology and relation to the environment. The whole fascinating story is told in words which create enthusiasm and stimulate further study and reflection. Older readers who were students when morphology was the main preoccupation of zoology will appreciate this book no less. It is easy to neglect or even to deprecate the beauty and significance of animal architecture, but this book avoids this error and also the older one of emphasizing it too much. By it the beginner will be prepared for the wider conceptions of modern biology.

The changes in this new edition are mainly amplifications of certain sections and additions wherever these are necessary to bring the book up to date. An outstanding feature of the book is its excellent diagrams, which are much better than those usually found in books of this kind. Some of these diagrams have been re-drawn; others are new. Eight new photographic illustrations of the earthworm and crayfish have been added; but some readers will wish that the space occupied by these had been given to really good and characteristic photographs or drawings of the animals dealt with in the chapter on the animal's background or to a better illustration than the one of the rabbit on p. 234. These would have helped other illustrations to remind the student that a diagram is only an interpretation of living structure and not a representation of it. Captious critics may detect one grammatical error, evidently missed in the proofs, namely, "The life-histories" . . . of nematodes . . . "is frequently complicated" on p. 628. Nematoda are classified as a phylum and not as a class of the Nemathelminthes. Although their uniformity of structure in spite of their success in a wide variety of habitats is noted, their great influence on the health of man and on his food supplies entitles them, some consider, to a more adequate treatment, even in a book for the beginner, than they receive here. Nor are the paragraphs on the pathology and control of the flatworm parasites adequate.

But these are, perhaps, minor criticisms. The beginner will not go far wrong if he selects this book, especially if he adds to it, for the sake of its philosophical and physiological outlook and the illustrations designed to resemble what is actually seen under the microscope, Woodger's "Elementary Morphology and Physiology for Medical Students". But, whatever books he uses, the student should never forget the advice given in the preface to the first edition of this book, namely, that the study of the animal is the essential thing, that a living animal is better than a dead one and that a dead animal is better than no animal at all. If this book is intelligently used, the student will not come excitedly to his teacher, as he has been known to come, with the information: "There's something wrong with my rabbit; it isn't like the book".
G. LAPAGE.

# ORGANIC CHEMISTRY

## Principles of Organic Chemistry

By Sylvanus J. Smith. Pp. viii+570. (London: Macmillan and Co., Ltd., 1944.) 15*s*.

THE author states in the preface that the object of this book is to provide a course in organic chemistry which a student may be expected to cover in about three years from starting the subject, and hence, quite rightly, the book does not follow rigidly the syllabus of any particular examining board.

The first two chapters give a brief survey of the determination of formulæ and physical properties, together with a discussion of isomerism and the electronic theory of valency. In view of the scope of the book it is a pity that no mention is made at this stage of the phenomenon of resonance; and it is unfortunate that a misleading structural formula has

been given to the ammonium ion, which has been repeated later on (pp. 176–177) for the substituted ammonium salts.

The paraffins and their aliphatic derivatives, such as alcohols, ethers, aldehydes, ketones, fatty acids and amines, are described in the following chapters; a pleasing feature of which is the number of graphs that have been given to show the relation between the molecular weights of homologues and their melting and boiling points.

After a short description of the olefines and acetylenes and their derivatives, a fairly detailed account is given of the dibasic acids, together with derivatives such as urea, ureides and diureides. The amino-acids and proteins are discussed in the same chapter as the hydroxy and keto acids, which is not a very suitable arrangement. The ultracentrifuge method of measuring the molecular weights of proteins is described, and the theory of the method is given in an appendix at the end of the book. A detailed account of the structure of the chief carbohydrates and of the reactions of the cyanogen derivatives and organo-metallic compounds is given.

Benzene and its more important derivatives are described adequately on the whole, although the account of the resonance effect on substitution in the benzene ring is too brief to be clear.

The heterocyclic compounds are illustrated in the main by a discussion of furane, furfural, pyrrole, indole, pyridene and quinoline. The terpenes and alkaloids are described in the closing chapters of the book, which also contains logarithm tables and a good index, as well as a wide selection of questions at the end of each chapter.

One of the outstanding features of the book is the large number of structural formulæ which have been given; but it is very unfortunate that apart from a few obvious misprints, several of these formulæ are based on obsolete structures; for example, ethylene ozonide, the Grignard reagent, and penta-covalent nitrogen in alanine, glycine, betaine, sulphanilic acid, etc. In this connexion it is surprising to find that although the modern formula for the nitro-derivatives has been given, the nitro-compounds are represented for the most part by the classical penta-covalent nitrogen structure.

Another criticism is that too much space has been devoted to obsolete or semi-obsolete processes, and many reactions which are now of far-reaching importance are omitted or given scanty treatment. Thus, the manufacture of methyl alcohol from wood spirit is described prior to, and in more detail than, the carbon monoxide – hydrogen method; while it is implied that the only technical preparation of acetone is from pyroligneous acid. No mention is made of the chlorination of acetylene and the subsequent preparation of useful solvents; and the polymerization of the olefines, now of supreme industrial importance, is dismissed in three lines.

The statement (with the accompanying equations) that the formation of an alkyl halide from an alcohol and hydrogen hydracid "structurally resembles the formation of a metallic halide from an alkali:

$$C_2H_5OH + HCl = C_2H_5Cl + H_2O,$$
$$NaOH + HCl = NaCl + H_2O."$$

will make the reader rub his eyes and wonder whether the theory of the complete ionization of strong acids and bases has been discarded.

On the whole, I do not consider that this book is suitable for use as a school text-book; but portions of it may be useful to university students, provided that due regard is paid to the criticisms made above. The book is printed in clear type on paper of good quality, and the binding is excellent for a war-time publication.

A. C. CAVELL.

# PSYCHIATRY FOR EVERYMAN

**A Handbook of Psychiatry**

By Dr. P. M. Lichtenstein and Dr. S. M. Small. Pp. 330. (London: Kegan Paul, Trench, Trubner and Co., Ltd., 1944.) 16*s*. net.

DURING the past three years, a number of books dealing with psychiatry have been published. They have all been condensed and mostly very well done. The present book by Lichtenstein and Small of New York presents the subject from a rather different aspect. It is described as "having been prepared not only for students of psychiatry, but for all those whose work brings them into contact with mentally disturbed persons". It is very well done, and will serve the purpose for which it was prepared extremely well. It will probably appeal most to the social worker and those whose work is almost entirely concerned with the mentally abnormal, but there are many relatives of those mentally disordered who might with great advantage read, mark and learn. Their attitude towards both patient, nurses and medical men might change greatly.

It is difficult to select any one chapter of the book as better done than any other. Naturally in a work so condensed and simplified it is difficult to deal adequately with subjects like psychotherapy and general principles of psychiatric therapy, but the reader will be able to realize how much progress has been made and is still being made in treatment in what is admittedly the most difficult branch of medicine.

It is a pity that in discussing the etiology of schizophrenia the authors do not mention the work of Hemphill and Reiss at Bristol on biopsy of the testicle. This work is confirming the general direction taken by the views of Mott put forward in 1922, which were afterwards rather discredited. The results of biopsy show very definite changes in the testicle. The modern view of paranoia does not accept the presence of hallucinations as part of the clinical entity. Both pellagra and beriberi are surely vitamin deficiency diseases and *not* infectious in origin.

We would like to see included under the senile disorders, Pick's disease. Alzheimer's disease is included as a pre-senile condition, and Pick's disease should be mentioned with it. It is a mistake to say that with electric shock treatment the patient has a complete amnesia after the experience. Some patients remember everything prior to the unconscious phase, and quite a few have a very decided objection to the treatment, often amounting to a definite fear.

Having regard to the amount of space devoted by the popular Press to the subject of psychosurgery, the section dealing with this most fascinating development in modern treatment might well have been considerably expanded. The mortality-rate in Great Britain is distinctly less than the 4–5 per cent quoted by these authors.

The book is well produced, very easy to read, and we recommend it heartily as an introduction to that most fascinating study—human abnormality.

G. W. T. H. FLEMING.

# INTERNATIONAL STATUS OF CRYSTALLOGRAPHY, PAST AND FUTURE*

By PROF. P. P. EWALD

IN the period between the War of 1914–18 and the beginning of the present War, crystallography experienced a rejuvenation, and in its new form of X-ray crystallography it has once more attained a central position bordering on many fields of promising development. While in its early days crystallography had contacts mainly with mineralogy, geology and crystal optics, at present its most intimate links are with atomic physics, chemistry, metallography and increasingly with engineering and industrial production. In fact, crystallography is forming the background for most problems concerning the solid state of matter. Compared to its advances on the newly won ground, its recent interactions with mineralogy and geology have been rather limited, but this may change in the future. It is recognized that crystallography stands in respect to its methods nearest to physics, for it originated as a part of physics; but the most urgent present demand for its methods and data comes from chemistry.

The early spread of research on crystals from the physical to the mineralogical and chemical laboratories in the first half of the last century prevented a consolidation of crystallography as such. It became, as it were, suspended between the three dominant disciplines. Even to-day, few universities have chairs of crystallography; crystallographic instruction is mostly given in the departments of mineralogy, but the departments of physics and of chemistry usually also give the bare minimum of crystallography which is needed for applications. In no country does there exist a learned society solely for the promotion of interest in, and knowledge of, crystallography. The results of crystallographic research have to be collected from physical, chemical, physico-chemical and mineralogical journals, besides being dispersed in the publications of learned societies. This was so before the days of structural crystallography; since then, biological, engineering and industrial journals have been added to the dispersal area of crystallographic work.

Nevertheless, there is a close connexion between the various sides, pure and applied, of crystallography. The underlying laws and the methods of observation and interpretation are the same, and progress made in one field may immediately benefit problems which seem altogether remote. The determination of unknown crystalline material from geometrical, optical or X-ray observations (to be mentioned again later on) shows the application of different methods to the same end; while the application of the same method in entirely different fields of research is exemplified by the X-ray determination of particle size and shape of clays, of metals and of catalysts.

The development of other subjects has led to their segregation from their original context. Astronomy and engineering have broken away from physics; physical chemistry, bio- and colloid chemistry from chemistry; there are societies devoted to the promotion of optics and acoustics, with the corresponding journals. This process of specialization, inevitable as it seems, is sometimes deplored as a disintegration of science. Should it not rather be looked upon as the formation of a new branch on the tree of science, which conveys the sap to a region hitherto not well provided for, a branch necessary for rounding off the shape of the tree as a whole? Crystallographic research might gain much by being clearly outlined as such and by being provided for by a Crystallographic Society with its own journal.

This idea is not new, as the history of the *Zeitschrift für Kristallographie* shows. It was a hundred years of development from Romé Delisle's first correct description of crystals to the foundation of this journal. Even then, in 1877, P. Groth could not venture to devote his journal to crystallography alone, but for financial and other reasons he had to make it a *Zeitschrift für Kristallographie und Mineralogie*. Fortunately, this foundation coincided with a time of rapid development, especially of chemical crystallography, and the editor, together with the great number of his students from all countries, contributed many important crystallographic papers, thus giving the *Zeitschrift* a bias towards crystallography. Groth's interest and experience ranged wide and were full of detail. This made his abstracts of crystallographic papers from other publications critical and stimulating, and he aimed at making them detailed enough to render the study of the original papers unnecessary to most readers of the *Zeitschrift*. From these reviews and from the hundreds of checks and corrections on the reported results which he got his untiring collaborators to carry out, there arose the five volumes of "Chemische Kristallographie", a monumental summary of the first great period of crystallography.

Groth edited fifty-five volumes of his *Zeitschrift*; then, in 1921, he handed it over to P. Niggli, of Zurich. At the same time a new publisher, the Akademische Verlagsgesellschaft, acquired the *Zeitschrift*. Niggli remained chief editor until 1940; owing to his not being subjected to the Nazi *Reichsschrifttumskammer*, and owing to the international connexions of the *Zeitschrift*, it was possible to maintain for it a freedom in editing which most scientific journals in Germany had to sacrifice in order to survive.

When Niggli took over, the time had at last come when mineralogy could be dropped from the title, which now read *Zeitschrift für Kristallographie* (*Kristallgeometrie, Kristallphysik, Kristallchemie*). Many of the papers offered to the *Zeitschrift* for publication, especially crystal structure determinations, came from abroad, and often after it had been found impracticable to obtain their full publication in the overcrowded physical and chemical journals, the bulk of the readers of which were not interested in the details of the work, or even competent to judge them. The absence of journals devoted to crystallography gave rise to great inconvenience, especially in the English-speaking countries. It was therefore decided to facilitate the publication of structural work in the *Zeitschrift* by 'internationalizing' it; that is, by accepting papers in French and English as well as in German. At the same time, prominent crystallographers all over the world were asked to act as patrons by allowing their names to figure on the title page and by entrusting the *Zeitschrift* with the publication of suitable parts of their research. The liberal answer to this request, and the use to which this mode of publication was put, fully justified the action taken. It was somewhat unfortunate that the steady but slow increase in number of subscriptions

* Part of an evening lecture delivered at the meeting of the X-ray Group of the Institute of Physics at Oxford on March 31, 1944.

could not balance the rapid increase in volume of production without imposing a heavy burden on the subscribers.

The *Zeitschrift für Kristallographie* never held, nor attempted to hold, a monopoly in the publication of structural work. Much of this went to the proceedings of learned societies, and much to chemical, physical and technical journals. This will always be so, as it is not easy even to define the class of work which from a rational point of view should go to a journal of crystallography rather than to any related journal. The same difficulty, however, arises between general and physical chemistry or radio engineering and physics. The decision to publish a particular piece of research in one journal rather than in another depends, apart from more personal grounds, on the nature of the research and on the public which the journal can be expected to reach. The aim of any scientific publication must be to reach those who are most interested in the paper and most competent to judge its merits. The fluidity of the boundaries between subjects is no argument against devoting a journal to any one of them.

The countermeasure to this inevitable centrifugal tendency of scientific publication lies in a reliable abstracting service. Owing to the fact that crystallography is suspended, as it were, between many acknowledged and firmly organized sciences, abstracts of crystallographic papers are to be found in some twenty abstracting journals in English, French and German. But with few exceptions no clear outline of the method and results of these papers can be gained from any one of the abstracts. Groth's ideal of fully summarizing the results quoted in the paper abstracted has been abandoned, and abstracts in most cases merely indicate the type of work presented in the paper.

Various ways were tried in the *Zeitschrift* of returning to the Groth type of abstract. For the limited field of structure determinations it could be attempted in the 'Strukturbericht', thanks to liberal financial aid given by the Notgemeinschaft der Deutschen Wissenschaft. As regards the entire field of crystallography, however, the attempts failed. Not only was the number of papers so great that the abstractors were unable to keep up with them, but also the variety of the work contained often in a single paper demanded abstracting under different headings and from widely diverging points of view; finally, the range that had to be covered to satisfy all those interested proved prohibitive from the point of view of cost to the reader. After trying out other systems, a classified collection of titles was all that could be produced. This, however, is very nearly contained in *Science Abstracts*, *Chemical Abstracts*, *Physikalische Berichte*, *Zentralblatt*, etc.; even if their classification is not quite so convenient as one drawn up for the purposes of crystallography, the gain is not worth paying the price of re-collecting and re-publishing the catalogue of titles.

A similar situation arises in other semi-independent parts of physics and chemistry, such as geophysics or colloid chemistry. It leads to a great amount of duplication of abstracting work. The problem of handling research work from the many points of view, such as methods, results, substances and properties, is so important, and at the same time so difficult, as to require a concerted effort on the part of all those interested; the methods of approach might well form the subject of further regional and international discussions.

Pending a better solution of this general problem, crystallographic research may best be reviewed and collected by an extension of the method adopted in the *Annual Reports of the Chemical Society* or in *Reviews of Modern Physics*. Here no completeness is aimed at, but selected topics are reviewed by particularly competent workers. By changing the subjects of the reports, a fair survey of the whole field is obtained in due course.

Apart from the tasks of publication and abstracting, the development of crystallography after the War of 1914–18 brought some other problems to the fore which required international settlement. The simpler crystal structures had been more or less explored by 1924, and the use of the theory of Schoenflies-Fedorow became imperative. Niggli, Astbury and Yardley, and Wyckoff had adapted this theory to practical requirements, each in their own way, with different origins and axes of the space groups, different symbols in the drawings and different items listed. Text-books which appeared had to choose between two evils: either to repeat all the results, if not the derivation of space groups, or to be quite incomplete for practical work. The preparation of standard tables of space groups was an obvious desideratum. The occasion to discuss it formally arose when, after a conference on crystal structure arranged by the Faraday Society in 1929, Sir William Bragg convened a meeting of the many crystallographers then present in London. Three committees were set up at this meeting to report (*a*) on the abstracting scheme, (*b*) the preparation of tables, (*c*) nomenclature. Their reports, delivered in the course of the next year, were published in the *Zeitschrift für Kristallographie*. The Tables Committee, after substantial preparation by correspondence, met in Zurich in 1930 and decided the details of the tables and the distribution of work among the British, American, French, German, Dutch and Swiss authors volunteering for it. These "International Tables for the Determination of Crystal Structures", edited by C. Hermann and published by G. Bornträger in conjunction with firms in the various countries, appeared in 1935, and were subsidized by the International Union of Physics and by many learned societies in the contributing countries. They have since found wide application for structure determinations.

One of the successful innovations in these Tables was the replacement of the conventional Schoenflies notation of space groups by a more rational one, developed by C. Hermann and Ch. Mauguin, which has a direct bearing on the symmetry, and therefore on the actual determination of space groups from X-ray data. Thus the recommendation of the Nomenclature Committee was incorporated in these Tables.

A further occasion for an international discussion was afforded by the International Congress of Physics, held under the auspices of the Union of Physics in London in 1934, one half of which was devoted to problems of the solid state.

No description of international relations in crystallography could overrate the influence of the two great British schools and centres of research, at the Royal Institution, and at the University in Manchester, both associated with the name of Bragg. Here students and scholars from all over the world received training and inspiration for crystallographic work; they made contacts among each other which wove them into a friendly international guild.

The present War has temporarily disrupted most of this texture, but it is certain that the desire for even closer international co-operation will return after the War in a subject so wide in extent and developing so quickly. A prelude to this is the regional consolidation of those interested in X-ray crystallography. In the United States, a Society for X-ray and Electron Diffraction was founded in 1940; its present membership is 350. In Britain, an X-ray Analysis Group of the Institute of Physics was formed in 1943, based on the success of several conferences on the subject which had been arranged by the Institute of Physics in the preceding years and which had shown attendances up to two hundred. In Germany the Deutsche Gesellschaft für technische Röntgenkunde arranged yearly conferences from 1929 onwards which dealt largely with the analysis and testing of materials by means of X-rays. Further regional or national organizations may be in existence or planned in other countries. They are to be welcomed, as they promote the interest taken in the subject, raise the standard of application and form a necessary stepping-stone for an international organization.

The desirability of forming, besides regional crystallographic societies, an International Union of Crystallography, should be clear, I believe, from past experience. Co-operation of all authorities is necessary to develop a subject with so many ramifications and applications to its optimum efficiency. In particular, the following topics seem to demand general agreement:

(1) *Publication.* It is undesirable that structural and other crystallographic work should be scattered in many journals, each of which only grudgingly concedes adequate space to it. A fair amount of concentration of this work in a single journal offers the obvious advantage of knowing where to look for it.

A journal like Groth's *Zeitschrift,* privately owned by a publisher, and therefore out of the control of the editors in important respects, is not ideal. It would be preferable to have a journal of crystallography owned by, and edited on behalf of, an International Union of Crystallography.

(2) *Archives.* The lengthy details of some structural work are of immediate interest only to the very few working on the same or closely related substances. It is unfair to make all the others pay for their publication. On the other hand, it is a generally accepted principle that only public tion of the details allows the necessary check on the author's work. As a way out of this quandary, it has been proposed to establish an archives for crystallography in which the full details submitted to the journal of crystallography would be kept in a form suitable for publication; anyone interested could obtain them at low cost on microfilm or in other photographic form. The manuscripts, as submitted to the editors of the journal, would have to give the complete argument, but on the proposal of the editors or the author certain parts of the details, mainly routine measurements, would be either relegated to the archives and replaced by a summary in the paper, or included in the paper at the author's cost.

These archives would also be used for depositing unfinished work of which only a summary description would appear in the journal.

(3) *Abstracts and Summaries of Crystallographic Work.* The collection of structural work and of phase diagrams could be carried on in conjunction with the archives and the journal. Summaries of experimental and theoretical work as proposed above could be arranged to appear. An important function of the Union would consist in representing the interest of crystallographers once the general problem of rationalizing the abstracting schemes in science comes to be discussed.

(4) *International Tables.* The first edition of these Tables is exhausted and a second edition should be prepared by pooling the experiences gained in the various laboratories where they have been in use. It is therefore desirable that the second edition should again be prepared by an international committee. Here also the question of property rights arises; it would be preferable to make the Tables the property of the Union, and to commission a publishing firm with the printing and distribution.

(5) *Analytical Tables of Crystals.* Various systems have been or are being worked out for determining unknown crystalline substances from geometrical, optical, or X-ray data (cf. J. M. Robertson, *Nature,* **154**, 350; 1944). These systems are still on a tentative scale, but it seems likely that a method of wide applicability will emerge, and with it the necessity for a systematic survey of all known substances. The detailed planning and the distribution of this work would best be done under the auspices of the Union.

(6) *General Tasks.* Lastly, a Union of Crystallography, represented regionally by its member societies, would act—to use an appropriate metaphor—as a nucleus of crystallization for the whole system of research on the structure and properties of matter in the solid and in related states. The Union and its members would be called upon to co-operate on particular problems with the Unions of Physics and Chemistry, with mineralogical and biological societies, and with those for testing materials. In matters of scientific instruction and of planning of research, the Union might arrive at well-considered recommendations in its field. Finally, the Union might act as a juridical person in matters requiring the handling of money.

A word should be said about the use of the term 'crystallography'. American and British societies referred to earlier have avoided this term in their names and have stressed instead the method of observation they wish to promote. The main reason for this may have been the fact that X-ray and electron diffraction methods are being applied also to substances which are not crystals, such as fibres, proteins, colloids, even liquids and the molecules in gases.

While the titles chosen give a clear indication of the main present activity of the respective societies, I would suggest that they imply a restriction which will ultimately be either abandoned, or prove undesirable. For any particular method, after having been applied for some time, tends either to become a routine method of observation, and as such of minor interest, or continually to be merged with other methods supplementing it from fresh sides. In the case of the X-ray method, this latter happened first when W. L. Bragg drew up a list of atomic radii. Later optical and magnetic observations, and the principles of atomic physics and of crystal chemistry which were being established, were added to the armoury supplementing the diffraction method. For how long will it be true that the main interest of the two societies lies in the diffraction and not in the supplementary methods? Are not many of their members interested mainly in applying the results gained by diffraction methods to the elucidation of

chemical, mechanical and physical properties? Is it not one of the main aims of these societies to link up X-ray diffraction with whatever chemical or physical methods seem promising to supplement it? The present circumscription of the societies' activities is decidedly too narrow.

'Crystallography', in its original meaning, does not, it is true, include the entire field of application of diffraction methods. But it covers the main field even then. 'Leptology', which Rinne coined for fine structure (λεπτός, fine), would be preferable to 'crystallography', but the word has not been generally introduced, and this might not be a good occasion to plead for it. Unless something new is adopted, however, 'crystallography' will have to be used in a wider sense than originally intended, so as to cover substances which for some purposes may be regarded as inferior forms of crystals; in them the arrangement of the atoms or molecules, while showing some kind of regularity, departs further from perfect three-dimensional symmetry, homogeneity and periodicity than in the actual piece of quartz to which the name of crystal was originally applied. The remaining regularity may, however, suffice to make profitable a close connexion of substances regarded from this aspect and of the old-time crystals, and it is this enlarged field which the term 'crystallography' should be understood to cover.

## 'PHENOXETOL' AND OTHER ANTIBACTERIAL SUBSTANCES

THE offensive against pathogenic micro-organisms continues to succeed, and a number of recent articles upon antibacterial substances indicate the widespread interest in them among non-medical workers and also the value of co-operation between scientific men—and especially biochemists—and the medical man. In a leading article last year the *Lancet* (781, June 19, 1943) discussed the evaluation of wound antiseptics and directed attention to Prof. Garrod's review of the recent advances that have been made (*Brit. Med. Bull.*, **1**, 48; 1943). W. A. Altemeier (*Surgery, Gynaec., and Obstetr.*, **75**, No. 6; 1942) has published a collective review of the bacteriology of war wounds (see *Bull. War Med.*, **4**, 60; 1943). Numerous articles in the *British Medical Journal* and the *Lancet* keep us continually informed of progress of research on this subject. Referring to the work in Sydney, Australia, of A. Albert, J. E. Falk and S. D. Rubbo (*Nature*, **153**, 712, June 10, 1944), the *Lancet* (148, July 29, 1944) discusses the antibacterial action of organic arsenicals such as arsphenamine and neoarsphenamine. Interesting also is the work on sulphasuxidine (succinyl sulphathiazole), some of which is hydrolysed in the lower bowel with the release of free sulphathiazole, which is effective in intestinal infections. It is stated in the *Lancet* (544, April 22, 1944) that E. J. Poth and C. A. Ross (*Proc. Amer. Soc. Pharmacol. Fed.*, Baltimore, **2**, 89; 1943) claim that sulphathalidine (phthalyl sulphathiazole) is two to four times more bacteriostatic than sulphasuxidine because it is more completely hydrolysed in the bowel. Combinations of sulphathiazole and proflavine in powder form have been recently successfully used by Prof. J. Macintosh and his colleagues (*Lancet*, 591, May 6, 1944) and by Major G. Y. Feggetter (*ibid.*, 593). Lieut.-Colonel J. W. Bigger (*Lancet*, 142, July 29, 1944) records his work on the synergic action of penicillin and the sulphonamides.

Penicillin is, of course, always in the picture. Sir H. W. Florey (*Brit. Med. J.*, 169, Aug. 5, 1944) gives yet another survey of progress of work on its action, and the same issue of that journal contains articles on the use of penicillin in ophthalmology and in acute empyema and on its combination with sulphonamides for the treatment of infantile gastro-enteritis. J. S. Jeffrey and Scott Thomson (*Brit. Med. J.*, 1, July 1, 1944) give their experience of the treatment of battle casualties in Italy with penicillin, and in the same issue (p. 15) a leading article discusses an American symposium on the uses of penicillin. In the *Lancet* (44, July 8, 1944) W. D. Jeans, J. S. Jeffrey and K. Gunders record their treatment in Italy of four cases of smallpox with penicillin. The pustules in these cases contained *Staphylococcus aureus*, and secondary infection must, these authors think, be responsible for much of the toxæmia in the later stages of the disease. The penicillin treatment was followed by marked improvement, and three of the patients survived, including one who had not been vaccinated. Most of the penicillin used in the Mediterranean theatre of war and for research purposes in Great Britain has been supplied by British manufacturers (*Brit. Med. J.*, 186, Aug. 5, 1944), who are now increasing their production of it: but we owe to the United States the solution of its large-scale production and the consequent saving of the lives of many British and American wounded.

Penicillin is, of course, active only against certain species of bacteria. As Prof. Garrod states (*Brit. Med. Bull.*, ii, 2, 1944), most of the species susceptible to it are Gram-positive, and these include the pyogenic cocci Staphylococcus, Pneumococcus and *Streptococcus pyogenes*, the gas gangrene group of organisms and those of anthrax and diphtheria. The tubercle bacillus and almost all the Gram-negative bacilli, including the typhoid-dysentery group and *Brucella, Hæmophilus* and those common invaders of wounds *Proteus* and *Pseudomonas pyocanea*, which produces blue pus, are resistant to penicillin; but the Gram-negative *Gonococcus* and *Meningococcus* are susceptible to it. There is great need, therefore (*Lancet*, 185, Aug. 5, 1944), for a substance which will control Gram-negative organisms. In the same issue of the *Lancet* (p. 175) is an article by H. Berry on the antibacterial action of ethylene glycol monophenyl ether, to which the name 'Phenoxetol' has been given. Prof. A. A. Miles, in his interesting Sydney Ringer lecture at University College Hospital Medical School on the epidemiology of wound infections (*Lancet*, 809, June 24, 1944), points out that Sir Alexander Fleming's work on the bacteriological history of an infected war wound has been abundantly confirmed. Spore-bearing and intestinal coliform bacilli predominate in the first phase; they are replaced by pyogenic cocci in the second phase; and in the third phase these cocci persist and flourish. To them may then be added *Pseudomonas pyocyanea* and *Proteus*. Sulphonamides or penicillin will control the cocci, and this is a great advance; but the control of them may enable *Ps. pyocyanea* and *Proteus* to become more active, so that healing may be delayed. Berry claims that *Ps. pyocyanea* is particularly susceptible to 'Phenoxetol'. The addition of 10–20 per cent of serum in his *in vitro* experiments with it did not depress its action on this organism, and Berry claims that his *in vitro* tests suggest that 'Phenoxetol' might perhaps be used with penicillin, the acridine

compounds (for a discussion of some recent work on these and on some other wound antiseptics see the *Lancet*, 90, Jan. 15, 1944), the sulphonamides and the quaternary ammonium compounds. 'Phemeride' ('Phemerol') is one of these and its action on bacteria is discussed by C. N. Iland (*Lancet*, 49, Jan. 8, 1944). It resembles the related substance 'Cetavlon' (CTAB) (see J. M. Barnes, *Lancet*, 531, i, 1942, and R. Williams *et al.*, *Lancet*, 522, i, 1943). Further work on the antibacterial action of organic detergents such as these should be interesting. The toxic action of 'Phemeride' and another detergent called 'Zephiran' on the tissues, and methods of studying their toxic action are discussed in an annotation in the *Lancet* (188, Feb. 5, 1944), together with work on the effect of antiseptics on the metabolism of bacteria.

J. Gough, H. Berry and B. M. Still (*Lancet*, 176, Aug. 5, 1944) have tried 'Phenoxetol' on wounds, some of which were war wounds, and on burns, tuberculous cavities and cases of infected dermatitis. Most of the injuries treated were granulating areas associated with loss of skin and the need of skin-grafting; and these authors are studying combinations of 'Phenoxetol' with penicillin, the sulphonamides and the flavines. They conclude that a daily application of 2·2 per cent solution of 'Phenoxetol' in water reduced the infection with *Ps. pyocyanea* or eliminated it and resulted in clinical improvement. The addition of 5 per cent 'Phenoxetol' to the sulphonamide cream, which contains 'Cetavlon', devised by the Burns Unit of the Glasgow Royal Infirmary (see *Med. Res. Council War. Memo.*, No. 10) was tried *in vitro* and the results were encouraging. But the toxicity of 'Phenoxetol' and its absorption need further study. It would seem that the blue pus of *Ps. pyocyanea*, which was so common during the War of 1914–18 and did not then give rise to much anxiety, will shortly be controlled. It is proving, Gough and his colleagues state, an increasing nuisance in plastic surgery and skin-grafting. If future work discovers an opposite number to penicillin which will act with an equal efficiency on the Gram-negative organisms, then the labours of all those who are conducting the offensive against pathogenic micro-organisms will be well rewarded. Their problem will then be the reduction of the considerable laboratory work which is necessary before a choice of antibacterial substance suitable for each case can be made.

Regulations governing the manufacture of penicillin have been issued by the Government. The manufacture and use of crude penicillium filtrate was discussed by J. M. Alston in the *British Medical Journal* (654, May 13, 1944). A further note in the same journal (314, Sept. 2, 1944) reviews two articles in American chemical engineering journals which describe the great effort which has been made to produce penicillin in quantity; it required the expenditure of millions of dollars at a time (1940 and 1941) when the sceptic might have doubted whether the effort was justified. More than twenty factories have been erected at a cost of some 20 million dollars. The *British Medical Journal* (250, Aug. 19, 1944, and 317, Sept. 2, 1944) publishes notes on the use of penicillin for civilian cases, and the Ministry of Health has issued two memoranda on the use of penicillin now being issued to medical schools free of charge for the treatment of civilians. Next year there may be enough of it for all requirements. R. J. McNeill Love (340, Sept. 9, 1944) records one of a number of air-raid casualties to whom penicillin was given as a prophylactic with very gratifying results. In a leading article the *Lancet* (348, Sept. 9, 1944) further discusses the manufacture and use of penicillin and gives further references. A. Dolphin (*Brit. Med. J.*, 317, Sept. 2, 1944) has described the treatment of ten civilian cases at a meeting of the Fever Group of the Society of Medical Officers of Health, which was opened by Sir Alexander Fleming.

# LA SOCIÉTÉ FRANÇAISE DE PHYSIQUE

AT the meeting of the Physical Society on November 9, the president, Prof. E. N. da C. Andrade, welcomed some French physicists, members of the sister society, la Société française de Physique. He said: "We have here Prof. P. Auger, Prof. G. A. Boutry and Dr. S. Rosenblum. Through the kind offices of M. Boutry, professeur au Conservatoire national des Arts et Métiers and a fellow of our Society, I have received a brief account of the history of the Société since the outbreak of war. In it the president, Prof. J. Cabannes, records the lamentable fate of many members whose names are known to, and honoured by, all of us." Prof. Andrade then read out the following names of those who had died, the assembly standing:

"G. Dechêne, J. Farineau, H. du Mesnil du Buisson and J. Rossignol fell on the field of honour in the early battles.

"F. Holweck, who made his name famous by his pump and by other ingenious instruments, by his work on soft X-rays and by other notable researches, was murdered by the Gestapo; and J. Solomon, one of the most promising of the younger theoretical physicists, was shot by the German military authorities.

"Deaths that we have to deplore, some no doubt accelerated by the traditional brutalities of the Germans, are those of H. Buisson, H. Chipart, A. Dufour, A. Guillet, Victor Henri, J. Lemoine, Jean Perrin, Émile Picard and Pierre Weiss.

"Besides those who are known definitely to have lost their lives, there are others whose ultimate fate is unknown. H. Abraham, Eugene Bloch, G. Bruhat, L. Cartan, C. Sadron and J. Yvon have been deported to Germany, and we dare scarcely hope that they have received humane treatment there. Of Paul Langevin, who received in 1940 the highest honour the Royal Society has to give, the Copley Medal, we have no news, unless M. Boutry has something to tell us.

"Let me assure our French friends that although, as Mr. Eden said yesterday, 'People in Britain do not yet fully understand how complete, how merciless, how dastardly has been the devastation inflicted by the German armies in Allied lands as they withdraw', some of us here have some comprehension of German brutality. . . ."

Prof. Andrade added that, in spite of obvious difficulties, "all through the troublous days of the German occupation, zealous and courageous French colleagues have kept alive the science of physics in France. In June 1941 appeared a new publication, the *Cahiers de Physique*; and the first number of another new publication, the *Annales de Géophysique*, is at this moment in the press. We congratulate our French brethren on the success of their strenuous efforts."

Turning then to M. Boutry, Prof. Andrade said: "Au nom de la Physical Society je vous prie de bien vouloir saluer de notre part nos camarades de la Société française de Physique et de leur dire combien nous regrettons le lamentable sort de nos confrères, victimes du maudit système Nazi, ou plutôt allemand, combien nous espérons voir renaître dans toute sa gloire traditionelle et la France et la physique française. Nous avons remarqué avec la plus vive émotion comment, au milieu de tant de dangers et de difficultés, les physiciens français ont continué leurs travaux désinteressés. Tout ce que la Physical Society peut faire pour encourager et appuyer nos collègues, nos amis français, soyez assuré que ce sera fait. C'est pour nous un très grand bonheur de pouvoir désormais renouveler nos cordiales et traditionelles relations avec la Société française de Physique. Cher collègue, soyez le bienvenu."

In the course of his reply, Prof. Boutry said that Langevin is alive and well.

# OBITUARIES

## Sir John Ledingham, C.M.G., F.R.S.

SIR JOHN LEDINGHAM, emeritus professor of bacteriology in the University of London and a former director of the Lister Institute of Preventive Medicine, died in London on October 4 after a brief illness. John Charles Grant Ledingham—'a son of the manse'—was born in 1875, his father, the Rev. John Ledingham, being the minister of Boyndie, Banffshire. He was educated at Boyndie Public School, Banff Academy, and the University of Aberdeen, where he achieved many successes including the Simpson and Arnott Prizes and the Anderson Scholarship. He graduated with first-class honours in mathematics and physics, obtaining the B.Sc. degree with distinction. After a brilliant career in the Faculty of Medicine he obtained the M.B. degree with honours in 1902. Postgraduate study at the University of Leipzig and at the London Hospital followed, and in 1905 he joined the staff of the Lister Institute, being appointed assistant bacteriologist at Elstree and afterwards to the main institute at Chelsea. In 1909 he succeeded George Dean as chief bacteriologist, and on the retirement of Sir Charles Martin in 1930 he was appointed director of the Lister Institute.

During his tenure of the directorship of the Lister Institute, one of the most responsible posts in preventive medicine, Ledingham proved himself to be an able administrator and supervisor of research, while finding time to pursue his own researches on experimental studies of viruses and virus diseases. His investigations regarding the elementary bodies from vaccinial and smallpox material were a notable contribution to this subject. Later he studied the morphology and conditions of growth of the organisms of pleuro-pneumonia and allied conditions. Earlier in his career he carried out studies on the causation of purpura hæmorrhagica in man, on the mechanism of phagocytosis and on the epidemiology of the typhoid carrier state. He retired from the directorship of the Lister Institute in 1943. The University of London in 1920 had granted him the title of professor of bacteriology and, after his retirement, the title of emeritus professor was conferred on him in the present year.

During the War of 1914–18, Ledingham was in charge of the Bacteriological Department of King George Hospital and served afterwards in the Royal Army Medical Corps, with the rank of lieutenant-colonel, as member of the Medical Advisory Committee in the Mediterranean area and as consulting bacteriologist to the Forces in Mesopotamia. For these services he received the C.M.G. in 1918. He was elected to a fellowship of the Royal Society in 1921 and was knighted in 1937. He received the honorary degree of LL.D. from his own University of Aberdeen and also the honorary degree of doctor of science from the Universities of Dublin and Leeds. He was appointed a member of the Medical Research Council in 1934 and served on many expert scientific committees, being chairman of the Tropical Diseases Research Committee of the Medical Research Council and the Royal Society and a member of the War Wounds Committee in the present War. He was chairman of the British National Committee of the International Association of Microbiologists, president of the Second International Congress for Microbiology which was held in London in 1936 and was an honorary president of the Third (New York) Congress in 1939. He was largely instrumental in the formation of the National Collection of Type Cultures, sponsored by the Medical Research Council and domiciled at the Lister Institute, and was its director from its inception in 1920 until his appointment as director of the Lister Institute.

Some thirty papers were published under Ledingham's name or in collaboration with others during the period 1920–43; one of his outstanding achievements being a book written jointly with Sir Joseph Arkwright entitled "The Carrier Problem in Infectious Diseases", which was published in 1912. He was a noteworthy contributor to, and an associate editor of, the "System of Bacteriology" in nine volumes published by the Medical Research Council in 1930–31, as well as to the Council's "Treatise on Diphtheria". In 1924 he delivered the Harben Lectures in London and in 1934 the Herter Lectures at Johns Hopkins University, Baltimore.

Sir John Ledingham married in 1913 Barbara, daughter of David Fowler. They had two children, a son and a daughter, both of whom are following the discipline of medicine. His scientific attainments were of a high order; his life was dedicated to scientific research, and by precept and example he stimulated enthusiasm in others. His kindly and unassuming nature endeared him to colleagues and associates, and above all to those who were honoured by his personal friendship. R. ST. JOHN-BROOKS.

WE regret to announce the following deaths:

Prof. G. D. Birkhoff, Perkins professor of mathematics in Harvard University, on November 12, aged sixty.

Prof. D. M. Blair, regius professor of anatomy in the University of Glasgow, on November 10, aged forty-eight.

Prof. R. J. Rowlette, King's professor of materia medica and pharmacy in the School of Physic, Trinity College, Dublin, and president during 1940–43 of the Royal College of Physicians of Ireland, on October 13, aged seventy-one.

Prof. F. J. Wilson, Freeland professor of chemistry, Royal Technical College, Glasgow, on October 18, aged sixty-four.

# NEWS and VIEWS

## Royal Society: Royal Medals

H.M. THE KING has approved of the following awards of the Royal Society:

Royal Medal to Prof. D. Brunt, professor of meteorology at the Imperial College of Science and Technology, London, in recognition of his fundamental contributions to meteorology.

Royal Medal to Dr. C. R. Harington, director of the National Institute for Medical Research, in recognition of his work in the analysis and synthesis of thyroxine, and in immunological chemistry.

## Nobel Prizes for Physics for 1943 and 1944

THE Nobel Prizes for Physics for 1943 and 1944 have been awarded to Prof. Otto Stern, research professor in the Department of Physics at the Carnegie Institute of Technology, Pittsburgh, and Prof. I. I. Rabi, professor of physics in Columbia University, New York, respectively.

### Prof. Otto Stern

Stern has developed the method of molecular rays into a powerful tool for the investigation of the properties of ultimate particles. His first application was the experimental verification of Maxwell's law of velocity distribution in gases. Then followed his famous work, in collaboration with Gerlach, on the deflexion of atoms by the action of an inhomogeneous magnetic field on the atom's magnetic moment; this provided direct evidence for one of the strangest statements of quantum mechanics, the so-called quantization of direction. By an almost incredible refinement of this method, Stern succeeded in detecting and measuring the (about 2,000 times smaller) magnetic moments of some nuclei, the proton and the deuteron. It is this work for which he has now been awarded a Nobel Prize. But he used his method also for other purposes. He gave the most striking proof for the wave nature of ordinary matter, as formulated by de Broglie, in producing interferences by rays of ordinary matter, hydrogen and helium, reflected by crystal surfaces. Stern has also published important theoretical papers on thermodynamics and quantum theory. He was professor of physical chemistry at Hamburg, and when he was compelled to leave Germany in 1933 he became a member of the staff of the Carnegie Institute of Technology, Pittsburgh, Pennsylvania.

### Prof. I. I. Rabi

Rabi is an American who worked for some time with Stern in Hamburg and is now professor at Columbia University, New York. He developed the same ray method to a considerable precision for the measurement of the magnetic properties of atomic nuclei. His apparatus is based on the fact that one can produce ordinary electromagnetic oscillations of the same frequency as that of the Larmor precession of atomic systems in a magnetic field. By an ingenious application of the resonance principle he succeeded in detecting and measuring single states of rotation of atoms and molecules, and in determining the mechanical and magnetic moments of the nuclei. A Nobel Prize has been awarded to him for his great contribution to our knowledge of nuclear magnetism.

## Nobel Prize for Chemistry for 1943: Prof. G. C. von Hevesy, For.Mem.R.S.

PROF. G. VON HEVESY, of the University Institute for Theoretical Physics, Copenhagen, has been awarded the Nobel Prize for Chemistry for 1943. Prof. von Hevesy's earlier work was mainly in the field of radioactivity and radioactive isotopes. He determined the valency and electromotive series of the radio-elements, and established the identity of radium D with lead. Investigations on the 'self-diffusion' in liquids and solids introduced the use of radio-elements as indicators in following the movements of common elements with which they are isotopic, and this technique he has developed in chemistry, physics and biology, where the use of 'tracer elements', which now include artificial radio-elements, has become very important in the elucidation of reaction mechanisms, and in following the processes of metabolism. Prof. von Hevesy's most recent work is in this field. His work with Brönsted on the separation of isotopes of mercury and chlorine by diffusion has become classical.

In 1923 Coster and von Hevesy announced the discovery of a new element, which they named hafnium (after Copenhagen), in zirconium minerals (*Nature*, 111, 79; 1923). The discovery was made by the X-ray spectrum method, and in later publications the use of this method in quantitative chemical analysis was developed. The search for hafnium in various minerals led to a broader interest in the distribution of the elements in the inorganic and organic worlds, and in problems of geochemistry.

Radioactivity was enriched in some later work on the activity of potassium and samarium, and the detailed study of the radioactivity of the rare earths. Apart from the discovery of hafnium, Prof. von Hevesy is perhaps best known for his work in the field of general radioactivity (in which chemical methods and interests have predominated), and on radioactive indicators, but his researches have spread into many fields, all of which have been enriched by his discoveries.

The Nobel Prize for Chemistry for 1944 has been reserved.

## Vladimir Komarov, President of the U.S.S.R. Academy of Sciences

VLADIMIR KOMAROV, president of the Academy of Sciences of the U.S.S.R., celebrated his seventy-fifth birthday on October 14. It also marked the fiftieth anniversary of his scientific work. Komarov holds many posts; thus in addition to being president of the Academy of Sciences of the U.S.S.R., he is chairman of the Council for Studying the Production Potentialities of the U.S.S.R., chairman of the All-Union Botanical Society and the All-Russian Society for the Conservation of National Resources, head of the Department of Geography in the Botanical Institute of the Academy of Sciences, and head of the Botanical Department of the University of Leningrad. In addition, he is editor of leading Soviet periodicals on biology and author of more than two hundred published works, including a number of monographs, text-books and papers of botanical interest. Komarov has taken part in, organized and directed nine large research expeditions in Central Asia, the Far East and Kamchatka, and has become the leading authority on the flora of Asia and particularly of the Far East. More than sixty plant species have been named after him.

Komarov's first major work was a "Flora of Manchuria", published in three volumes during 1901–7. His second big work was "An Introduction to the Flora of China and of Mongolia", published in 1908; and his third great contribution to science is his "Flora of the Kamchatka Peninsula", which appeared in three volumes during 1927–30. Apart from these works, Komarov has published a description of his travels through Kamchatka, and a number of essays on the botany and geography of the Far East. The publication of the "Flora of the U.S.S.R." was begun in 1934 under Komarov's direct supervision. It runs into twenty or so volumes and contains a description of all plants known to exist on the territory of the U.S.S.R.

Komarov adds public activities to his scientific work. He is a deputy of the Supreme Soviet of the U.S.S.R. and a member of the Far East Territorial Executive Committee. During the German invasion, Komarov went to Sverdlovsk, where he organized the Commission for Mobilising the Resources of the Urals, Western Siberia and Kazakhstan for war needs. For its work the Commission was awarded the Stalin Prize in 1942. Komarov has been awarded the title of Hero of Socialist Labour, the Order of Lenin, and the Hammer and Sickle Gold Medal, for outstanding scientific work and his service in the organization of Soviet scientific institutions. The Academy of Sciences is to publish a biography and selected works of Komarov; it is also establishing in the Academy of Sciences an annual Komarov Prize of 20,000 roubles for the best work in botany, and eight Komarov fellowships in botany at the Universities of Leningrad and Moscow and the Botanical Institute of the Academy of Sciences. A children's home named after Komarov is to be opened in Moscow for children of scientific workers who perished at the front during the present War.

## Chair of Zoology at University College, Cardiff: Prof. James Brough

AT the opening of the present session, Prof. James Brough entered upon his new duties as professor of zoology and comparative anatomy in University College, Cardiff, a post upon which distinction had been conferred by the personality and prosperous tenure of the late Prof. W. M. Tattersall. The appointment is an interesting one, because Brough's honours degree, taken at Armstrong College, Newcastle upon Tyne, was in geology, and his published researches are almost entirely palæontological. But he has used his geological knowledge with the avowed and persistent aim of interpreting the evolutionary history of the bony fishes, and his researches have already thrown new light on that difficult problem and have proved to be of fundamental importance for the study of the Palæoniscids. To further these studies he has travelled far and wide, adding to his material by collecting in South Africa and Rhodesia, in the Austrian Alps, in northern Italy and in Spitsbergen, studying in London and Edinburgh, in Stockholm, Paris, Frankfort and Milan. His zoological knowledge, reinforced by his palæontology and his own vivid personality, gave verve and imagination to his teaching in the Department of Zoology in the University of Edinburgh, from which he proceeded to Cardiff, and in his earlier post in the University of Manchester. During the War, he has assisted the Ministry of Food by acting as insect infestation inspector for the south-east district of Scotland. Dr. Brough's interest in educational methods and his researches, with which must be linked the studies in the early history of the Amphibia so successfully followed by his wife (Dr. Margaret Steen), promise well for the continued prosperity of the Department of Zoology at Cardiff.

## Prof. Frank Goldby

PROF. FRANK GOLDBY, Elder professor of anatomy in the University of Adelaide, has been appointed to the chair of anatomy at St. Mary's Hospital Medical School, London. Goldby entered Caius College, Cambridge, as Tancred Student and Scholar in 1920 and obtained first-class honours in Part I and Part II (Anatomy) of the Natural Sciences Tripos. In 1923 he was awarded the Frank Smart Research Studentship and spent a further year in Cambridge working under the direction of Prof. J. T. Wilson. His clinical studies were pursued at King's College Hospital, London, where he came under the influence of Kinnier Wilson. He qualified M.R.C.S., L.R.C.P. in 1925, M.B., B.Ch. in 1927 and M.R.C.P. in 1928. During these years he held various residential appointments at his hospital, including the post of assistant pathologist.

In 1931, largely on the advice of Elliot Smith, Goldby became demonstrator of anatomy at University College, London, and in 1932 he went to Hong Kong as lecturer in charge of the Anatomy Department during the absence on leave of Prof. Shellshear. In 1933 he returned to Cambridge as demonstrator of anatomy, and, when Prof. H. A. Harris, of University College, London, succeeded Prof. J. T. Wilson in 1934, Goldby was promoted to a University lectureship in anatomy and was elected fellow and afterwards steward of Queens' College. In 1937, on the return of Prof. Wood Jones to Manchester, Goldby was elected to the Elder chair of anatomy in the University of Adelaide. Prof. Goldby's researches have been mainly in the field of neurology, and range from epibranchial placodes in the head region of the sparrow, over the cerebral hemispheres of the reptile to the visual pathway in mammals. In 1936 his thesis on "The Experimental Investigation of the Cerebral Hemispheres of Lacerta viridis" gained him the Cambridge M.D. and the Raymond Horton Smith Prize.

## Dr. Murray Macgregor

THE Clough Memorial Medal of the Edinburgh Geological Society for the years 1943–44 has been awarded to Dr. Murray Macgregor in recognition of his outstanding contributions to the geology of Scotland and in particular of the Scottish coalfields. During Dr. Macgregor's long service on the Geological Survey in Scotland, where he has been in charge since 1925, his main task as a worker and administrator has been connected with the geology of the Scottish coalfield area. In his extensive series of original contributions in this sphere, his presidential address to the Geological Society of Glasgow in 1927, entitled "Scottish Carboniferous Stratigraphy", was an outstanding work. Dr. Macgregor has achieved conspicuous success in organizing increasingly detailed work on Scottish mineral deposits and in promoting close collaboration with the mining and industrial community. He has thus been in a position to give authoritative advice to the Scottish Coalfield Committee, appointed by the Secretary of State for Scotland in 1942, and to make important contributions to this Committee's report, now in course of publication. Dr. Macgregor has also made valuable

contributions to the geology of the rocks of the Highlands and of the glacial deposits of central Scotland, and he played a big part in the preparation of the Scottish exhibits for the opening of the new Geological Museum in London in 1935.

## British Empire Cancer Campaign

At a recent meeting, the British Empire Cancer Campaign allocated a sum of £39,000 for the continuation of cancer research during the calendar year 1945. This sum compares with grants totalling nearly £36,000 for the present year. The principal grants are as follows: £10,613 to the Royal Cancer Hospital (Free), including the Chester Beatty Research Institute; £8,000 to the Middlesex Hospital; £3,500 to St. Bartholomew's Hospital; £1,800 to the London Hospital; £2,743 to Mount Vernon Hospital and the Radium Institute; £850 to St. Mark's Hospital, City Road; £1,100 to the Marie Curie Hospital; £120 to the Bristol University Cancer Research Committee; £2,300 to the Cambridge University Cancer Research Centre; £1,740 to the Oxford University Cancer Research Centre; £1,125 to Westminster Hospital; and £5,165 for the expenses of cancer research at the Glasgow Royal Cancer Hospital, University of Glasgow, Institute of Animal Genetics of the University of Edinburgh, University College, Nottingham and St. Thomas's Hospital. These grants are additional to independent expenditure on cancer research by the autonomous branches of the British Empire Cancer Campaign in Birmingham, Yorkshire, Lancashire, Cheshire, North Wales, Northumberland, Cumberland and Durham.

## Pest Control in French North Africa

A recent publication ("Les Nouvelles Méthodes Insecticides et Les Épidémies." By Dr. A. L. Lepigre. Centre Nationale de la Recherche Scientifique, Algiers) describes what is being done to reduce losses at the ports, in the marshalling yards and in the agricultural depots in French North Africa, resulting from infestation by insects and rats. The loss of potatoes caused by the tuber moth is stated to exceed 50 per cent within three months of harvesting, most of which loss is preventable by fumigation. Dr. A. L. Lepigre, whose pioneer work on the fumigants ethylene oxide and methyl bromide is well known, describes the fumigants and methods now in use in the eight large official stations for *désinsectisation* in Algiers, and the possibility of using vacuum and mobile chambers. Ethylene oxide, hydrogen cyanide and methyl bromide are recommended; but it seems that ethylene oxide is not available in Algiers at present. Chlorpicrin, once highly favoured by the French authorities, is described as being too unpleasant. A brief account of these fumigants is given, and special interest is attached to the statement that ethylene oxide is bactericidal as well as insecticidal, and as such is probably more effective than formalin or sulphur dioxide.

The need for specialists trained in fumigation practice is specially stressed. Loss of lives by typhus, and loss of foodstuffs and other commodities, still occur on a large scale, losses which can on Dr. Lepigre's showing be prevented if the organization of trained staff and equipment, which he describes, can be provided. That is true of many military and civilian bases and depots apart from the North African—in India for example—but there is little prospect of effective action until trained practitioners are available.

## British Rheologists' Club

The fourth annual general meeting of the British Rheologists' Club was held at the University, Reading, on Saturday, October 21. The retiring president, Commander C. F. Goodeve, took the chair at the business meeting. The following were elected officers for the ensuing year: *President*, Prof. E. N. da C. Andrade; *Hon. Secretary*, Dr. G. W. Scott-Blair; *Hon. Treasurer*, Dr. V. G. W. Harrison. The following were also elected to the Committee: Mr. R. L. Brown, Dr. C. A. Maunder Foster, Dr. E. W. J. Mardles, Dr. L. R. G. Treloar. Dr. Scott-Blair reported an increase of more than ninety in the membership figures during the past year. There had been three general meetings, of which one had taken the form of a week-end conference. This had led to closer co-operation between rheologists working in numerous fields. The Committee especially welcomed the newly established contacts with metallurgists. Very cordial relations existed with the (American) Society of Rheology, and it was hoped in the near future to make contact with Soviet rheologists through the courtesy of the Embassy of the U.S.S.R. The business meeting was followed by a discussion on "Tack" introduced by Dr. N. A. de Bruyne and Mr. R. F. Bowles.

## Dust Precipitation from Boiler Flue Gases

A paper on this subject was read in London on November 2 before the Institution of Electrical Engineers, by John Bruce. In it the author deals particularly with the electrostatic precipitation of dust entrained by flue gases produced from the combustion of anthracite in pulverized form. The paper describes field experiments and results on a pilot-scale electrostatic precipitator operating on such flue gases, as well as the salient features of a large-scale commercial installation. Some of the operating results obtained therefrom are also discussed.

## Announcements

Prof. M. N. Saha, of the University College of Science and Technology, Calcutta, will deliver a lecture before the Physical Society on "A Physical Theory of the Solar Corona" on November 23, at 5.0 p.m. The lecture will be given in the rooms of the Royal Society, Burlington House, Piccadilly, London, W.1, and members of the Royal Astronomical Society are also invited.

The Melbourne correspondent of *The Times* announces that Mr. W. Russell Grimwade, a member of the Council of the University of Melbourne, has given the University £A50,000 for the foundation of a school of biochemistry devoted both to teaching and research. Mr. Grimwade, who is chairman of the directors of Drug Houses (Australia), Ltd., manufacturing chemists and druggists, has been active in the war-time production in Australia of drugs previously imported.

From time to time correspondents have written offering to present unwanted issues of *Nature* to institutions or libraries. In view of the many losses sustained by French universities and libraries during the German occupation, and the difficulty in replacing such losses, readers may like to know that Prof. P. Auger, Commissariat de l'Education Nationale, 1 Carlton Gardens, London, S.W.1, is prepared to receive copies of *Nature* for dispatch to France.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## A Severity-Rate for Industrial Accidents and Sickness

THE effects of economic and social conditions upon absence from work initiated by sickness and injury are especially important at the moment in view of the changes in workmen's compensation arrangements proposed by the White Paper on Social Medicine and other similar publications.

All factories keep records of sickness and accident incidence, though they vary in detail. A factory showing a low rate of accident is not necessarily one where every possible safety measure is applied. A low accident-rate might equally well be due to inadequate facilities for reporting injury—an out-of-the-way first-aid room, an unsympathetic medical staff, or wage and compensation arrangements which make the workers fear loss of working time and so to carry on without reporting sickness or injury unless and until it proves serious. Such delayed reporting cases nearly always prove more serious than they would have had they received prompt medical attention.

These factors, which are external to purely industrial risk, considerably invalidate estimations based on the reported incidence of sickness or accidents. A secondary measure is required—a measure of the severity of reported cases. Severity, in this connexion, is best defined as the absence from work caused by sickness or injury.

Three main forms of severity estimation have been available for the preparation of accident statistics.

(1) 'Disabling accident' rate. Accidents which involve more than three days absence from work are reportable under the Workmen's Compensation Act and the Factory Acts. To this is often added a 'severe accident' rate, defined by the nature of injury. These are usually expressed as rates per 1,000 men (per year) or per 100,000 man-shifts.

(2) 'Lost time' records. Absence is recorded by an accountancy system in which cases still absent at the end of a records period are carried forward into the subsequent period. Thus the statistics are not completely related to any one records period. Arbitrary 'terminations' are introduced to avoid the cumulative effects of the very long term absences. Fatalities are considered separately.

(3) Estimation of lost time by the International Labour Office Severity Scale. This tabulates the average lost time caused by various injuries. It facilitates rapid preparation of statistics; but, by its nature, it is not susceptible to the effects of changes in economic or social conditions.

The following account briefly describes a new measure. It is approximate only, but further work is being carried out to diminish its error.

Given that the minimum delay in preparing sickness and accident statistics is desirable for practical purposes, an absolute measure is impossible. The aim, therefore, was to discover a theoretical distribution approximating to the actual distribution of absence, the constants of which could be calculated from incomplete data. The theoretical distribution chosen is that of the exponential law of decay. Its constants are (i) the origin, taken as the number of cases involving more than three days absence (conforming to the Workmen's Compensation and Factory Acts) and (ii) the logarithmic decrement, calculated from the origin and the number of cases involving more than thirty days absence. The thirty days specification is arbitrary, and is used so that the theoretical distribution can be calculated one month after the end of the records period. Thus each records period has self-contained statistics, and there is no need to take separate account of fatalities or cases of prolonged absence, although further work is required to make the extrapolated curve a more accurate estimate of these cases.

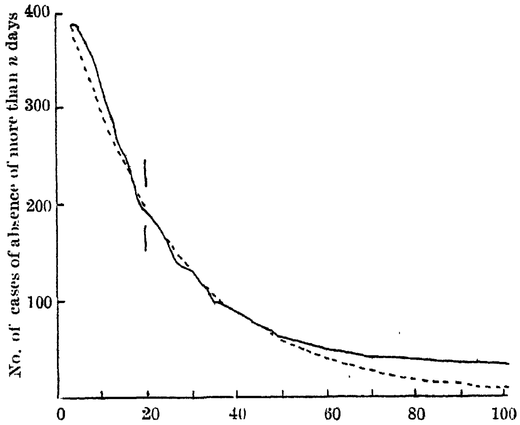


Fig. 1. DATA FOR 1938, 39, 40. FULL LINE, ACTUAL DATA; BROKEN LINE, THEORETICAL DISTRIBUTION. MEDIAN ABSENCE, 19·06 DAYS.

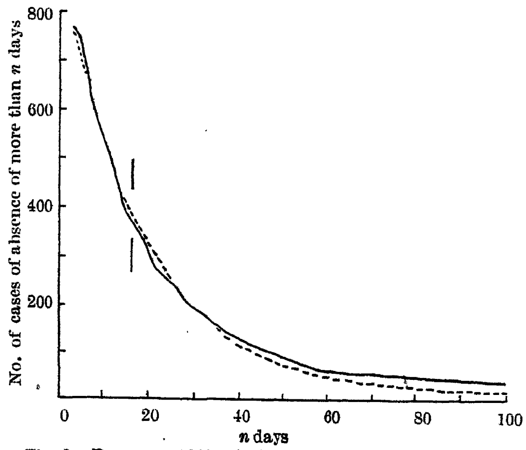


Fig. 2. DATA FOR 1941, 42, 43. FULL LINE, ACTUAL DATA; BROKEN LINE, THEORETICAL DISTRIBUTION. MEDIAN ABSENCE, 16·27 DAYS.

In the examples given (see accompanying graphs) number of cases of absence of more than $n$ days is plotted against $n$. The logarithmic decrement is calculated:

$$\text{Logarithmic decrement} = \frac{\log A_3 - \log A_{30}}{27},$$

where $A_3$ is the number of cases absent for more than 3 days and $A_{30}$ is the number of cases absent for more than 30 days.

The theoretical distribution is calculated:

Expected $A_n = \frac{A_3}{e^{x(n-3)}}$, where $x.\log e$ is the logarithmic decrement.

It is convenient to transform the logarithmic decrement into the half-period of decay. This gives the median absence:

$$\text{Median absence} = \frac{0{\cdot}3010}{\text{log decrement}} + 3 \text{ days.}$$

The graphs show the method demonstrating a change in severity during the war years. Data are from one firm which has not changed its processes during this period, nor has there been any major change in the quality of labour employed. The disabling accident rate for 1938, 1939, 1940 is 86 per 100,000 man-shifts, and for 1941, 1942, 1943 it is 118 per 100,000 man-shifts. By themselves these figures suggest a large increase in risk during the later war years. Absence medians show a decrease in severity of reported accidents during the latter period (medians at 19·96 and 16·27 days for the two periods). Thus the increase in accident-rate can be attributed in part to increased willingness to report injury and to take immediate absence of short duration. The main social and economic changes likely to have caused this increased willingness to report and be absent are higher wages, more secure employment, revised compensation arrangements and regulations against absenteeism.

If we consider each year separately

| Year | Rate per 100,000 man-shifts | Median absence |
|---|---|---|
| 1938 | 90 | 21·9 |
| 1939 | 94 | 17·7 |
| 1940 | 78 | 20·5 |
| 1941 | 105 | 17·7 |
| 1942 | 119 | 15·4 |
| 1 43 | 131 | 16·8 |

These show the general trend of increase in accident-rate and decrease in severity during the war years. The exception noted for 1940 is presumably to be explained by the overriding pressure of work in the summer and autumn of that year, when the workers realized the urgent need of supplies and considered personal injury of minor importance.

Similar treatment of data from other sources shows a difference in severity of accidents reported by full-time workers and by part-time workers.

The conclusion is that reporting of sickness and injury in industry may be affected by factors unrelated to industrial risk. Comparative work must consider the severity of the reported cases. The median absence, obtained by the method described above, is recommended as a measure of severity.

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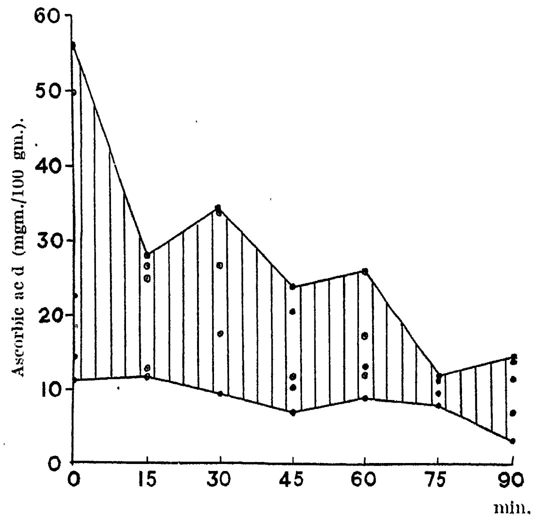
## Sampling of Cooked Cabbage in Nutrition Surveys

IN the course of an investigation which we carried out at a local hospital during the winter, it became necessary to estimate the loss of ascorbic acid which occurred in cabbage in the interval between the completion of cooking and consumption in the wards and dining-rooms. This interval was usually between thirty minutes and one hour, during which time the cabbage was kept in water-jacketed boxes at 60–70° C. We failed to obtain satisfactory duplicate analyses of samples taken in the hospital, and it was therefore decided to carry out experiments under similar conditions in the laboratory.




Cabbage was cooked, strained and kept at 60–70° C., samples being taken at intervals. The ascorbic acid content was estimated by titration with 2 : 6 dichlorophenol-indophenol, using a sulphuric acid/metaphosphoric acid solution for stabilizing the vitamin between sampling and estimation. It was again not found possible to obtain agreement between either duplicate or triplicate samples. Reference to the literature in which satisfactory analyses are given[1] revealed the fact that the cabbage used was either minced or finely chopped. We can confirm that there is no difficulty in obtaining good agreement between replicate samples of cabbage under these conditions. But a difficulty arises when it is not possible to use methods for homogenizing the cabbage, as in field work, where samples taken for analysis are usually those actually put out on to plates during the service of the meal. The results given in the papers referred to above apply only to ideal conditions which are rarely encountered in work of this sort.

An example of our results is given in the accompanying graph, which shows an attempt to construct a curve recording the loss of ascorbic acid on keeping cabbage hot. Five samples were taken at each time interval. An even wider variation in values was obtained when ten samples were taken; for example, 32–75 mgm.; 25–78 mgm. and 11–56 mgm. per 100 gm. cabbage. Some of these values are as much as $\pm$ 70 per cent from the mean. Care was taken that the samples analysed did not consist almost entirely of stalk or of leaf.

The experiments suggest that in field work, where an attempt is made to assess the ascorbic acid content of food actually consumed, it is not possible to obtain trustworthy results unless the food is normally mashed or minced before serving.

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[1] McHenry and Graham, *Biochem. J.*, **29**, 2013 (1935). Olliver, *J. Soc. Chem. Ind.*, **55**, 153T (1936). Gould, Tressler and King, *Food Res.*, **1**, 427 (1936). Stone, *Biochem. J.*, **31**, 508 (1937). Olliver, *Chem. and Ind.*, 587 (1941). Lampitt, Baker and Parkinson, *J. Soc. Chem. Ind.*, **62**, 61 (1943).

## Distribution of Antithyroid Activity in Tissues

CONTINUING our investigation of the antithyroid function of paraxanthine and related compounds[1], we have carried out estimations of the antithyroid activity in mammalian tissues and blood.

All the extracts were made by methods similar to that described in our previous letter except that the purification was not carried beyond the mercury precipitate. The extracts at this stage contain other substances besides paraxanthine and it is possible that some of these are active. We have indeed evidence that suggests that the active substance in thyroid extracts is not identical with paraxanthine, though it appears to be related to it and may perhaps be formed from it in the body. Work on the identification of this substance is being continued.

In these circumstances we do not wish to contend that the active substance in any of the organs or fluids is paraxanthine, except that in liver, from which (as from urine[1]) paraxanthine has been isolated. It is, however, convenient to report the results in terms of paraxanthine, that is, as the concentrations of paraxanthine that would give the activities present in the extracts, and this we have done.

The true tissue contents will be higher than are given here owing to loss during the extraction. But since the process of extraction was similar for all the extracts, it is probable that the losses were of the same order in them all.

Antithyroid activity was estimated by the method described in the previous letter, in which use is made of the change of form of the temperature/heart-rate curve of the frog's heart. We have checked the accuracy of this method by estimating the paraxanthine in three solutions the strengths of which we did not know at the time of estimation. Our results were within 10 per cent of the true concentrations. We think that 20 per cent is the largest error that is likely to occur in the estimations. This error would not include losses during extraction.

Our results are given in the accompanying table. Each figure gives the result of extractions from a single sample of tissue, except the figures for liver which give the range of ten extractions.

| Tissue | Source | Content $\mu$ gm. per gm. (wet weight) |
|---|---|---|
| Skeletal muscle | Cattle | 1·2 |
| Heart muscle | Cattle | 2 |
| Small intestine | Pig | 1·7 |
| Lung | Cattle | 1·4 |
| Liver | Cattle | 0·2–0·9 |
| Ovary | Cattle | 8 |
| Testis (immature) | Pig | 4 |
| Brain | Cattle | 5 |
| Spleen | Cattle | 10 |
| Thymus | Cattle | 8 |
| Pituitary | Cattle | 8 |
| Pancreas | Cattle | 6 |
| Thyroid | Cattle | 500, 600, 750, 470. |
| Thyroid | Human (normal)* | 600, 1,400, 750, 1,000, 833, 666, 700, 800, 830, 850, 770, 950. |
| Thyroid | Human (thyrotoxic)* | 245, 133, 165, 105. |
| Thyroid | Human (adenoma)* | 1,100, 1,100, 1,250. |
| Whole blood | Cattle | 0·4 (per c.c.) |
| Whole blood | Pig | 0·15 ,, ,, |
| Blood cells | Cattle** | 0·0059 ,, ,, |
| Plasma | Cattle** | 0·176 ,, ,, |

* We are greatly indebted to Prof. H. M. Turnbull, of London Hospital, for these samples.

** From the same sample of blood. Content of the whole blood of this sample 0·132 $\mu$gm. per c.c.

The most striking features of these results are: (1) the very high activity of the extracts of thyroid tissue—on the average an extract of normal thyroid is 400–500 times as active as extracts of tissues such as muscle, intestine and lung; and (2) the wide variation of the activity of the thyroid extracts with the condition of the gland. In general, the concentration of antithyroid activity in the tissues runs parallel with the amount of iodine they contain. This is so in the thyroid as compared with other tissues, and it is also shown in the slightly higher contents of glandular tissues as compared with non-glandular[2]. Our thyrotoxic thyroids came from patients which had been treated with iodine before extraction of the gland; they would have contained as much iodine as normal thyroids[2]. It is of interest to find that the antithyroid contents of thyrotoxic thyroids are relatively low even after treatment with iodine.

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[1] *Nature*, 151, 728 (1943).
[2] Elmer, "Iodine Metabolism and Thyroid Function", 82, 86 (1938).

## Anti-sulphanilamide Activity of 2-Aminopyrimidine-5-carboxylic Acid

THE observation of Woods[1], that the anti-bacterial activity of sulphanilamide is inhibited by *p*-aminobenzoic acid, has been followed from time to time by observations recording a similar anti-sulphanilamide action for other compounds chemically unrelated to *p*-aminobenzoic acid. Thus Harris and Kohn[2] have shown that *dl*-methionine antagonizes sulphanilamide action. Martin and Fisher[3] have reported that adenine possesses anti-sulphanilamide activity in mice infected with streptococci comparable with that possessed by *p*-aminobenzoic acid. Snell and Mitchell[4] found that adenine, guanine, xanthine and hypoxanthine, as well as *dl*-methionine, reversed sulphanilamide bacteriostasis of certain lactic acid bacteria, although the results were largely dependent on the particular organism and conditions employed. Anti-sulphanilamide action has also been demonstrated with urethane[5].

In the course of biological examination of some pyrimidines, we have recently examined 2-aminopyrimidine-5-carboxylic acid[6]—an acid bearing a close structural relationship to *p*-aminobenzoic acid. It displayed no anti-bacterial action against *Streptococcus pyogenes in vitro*, but possessed distinct sulphanilamide inhibitory powers, although in smaller degree than *p*-aminobenzoic acid. Thus *p*-aminobenzoic acid was found to be 2,000 times as effective as 2-aminopyrimidine-5-carboxylic acid in inhibiting sulphanilamide bacteriostasis of *Streptococcus pyogenes in vitro*.

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Sept. 19.

[1] Woods, D. D., *Brit. J. Expt. Path.*, 21, 74 (1940).
[2] Harris, J. S., and Kohn, H. I., *J. Pharmacol.*, 73, 383 (1941).
[3] Martin, G. J., and Fisher, C. V., *J. Biol. Chem.*, 144, 289 (1942).
[4] Snell, E. E., and Mitchell, H. K., *Arch. Biochem.*, 1, 93 (1942).
[5] Johnson, F. H., *Science*, 95, 104 (1942). McIlwain, H., *Science*, 95, 510 (1942).
[6] Ballard, E., and Johnson, T. B., *J. Amer. Chem. Soc.*, 64, 794 (1942)

## Preparation of Cell-free Plasma Coagulase of *Staphylococcus aureus*

IN 1908, Much reported that certain strains of *Staphylococcus* had the property of coagulating oxalated or citrated human blood plasma. This is nowadays considered as one of the most characteristic features of pathogenic *Staphylococcus aureus*, and is used to differentiate it from various other cocci. To my knowledge, attempts to separate the plasma coagulase from the bacterial cells have so far failed; for example, in personal experiments by filtration of broth cultures through Seitz and Chamberland filters, separation of cells by the centrifuge, killing the staphylococci by heat or the vapour of ether or chloroform.

In order to explain the inactivity of the filtrate or centrifugate, it has been taken as a working hypothesis that coagulase is not produced in such cultures, but is formed only in presence of plasma. This also had another basis in my finding that the rate of coagulation was independent of the age of broth cultures and was uninfluenced by repeated washing of the suspensions. Such results were opposed to the existence of preformed coagulase in cultures on ordinary media.

To verify the hypothesis that coagulase is produced only in contact with plasma, 10–25 per cent of human citrated plasma was added to a series of flasks containing nutrient broth. Control sets contained broth, and broth with sodium citrate only. All were inoculated with *Staphylococcus aureus*, three separate strains being tested. After twelve hours incubation at 37° C., the cultures were centrifuged and the supernatant fluid filtered through Chamberland *L*3 filters. The filtrates, which were tested for sterility, were added in various amounts to separate 1 c.c.'s of concentrations of human citrated plasma ranging from full strength to 1 : 40 in 0·85 per cent sodium chloride solution. While filtrates of broth and broth *plus* citrate were inactive, the filtrates of plasma-broth cultures showed a very strong coagulating power; for example, one drop of 1 : 10 dilution coagulated concentrated plasma in two hours and 1 : 10 plasma in fifteen minutes. Thus it appears that cell-free plasma coagulase can be obtained when *Staphylococcus aureus* is grown in presence of human plasma.

There is also abundant production *in vivo* by *Staphylococcus aureus* of plasma coagulase, which can be demonstrated readily in pus, etc. This 'direct coagulase test', which will be described elsewhere, affords a very rapid and reliable method of detecting staphylococcal infections.

After the above letter was written, my attention was directed to a paper by W. Smith and J. H. Hale[1], who found that by means of 'Gradocol' membranes coagulase could be demonstrated in broth culture filtrates. It is of interest that, as I observed, the addition of plasma to a broth culture led to the appearance of coagulase which was easily filterable through filters of the Chamberland type, whereas in absence of plasma neither centrifugates nor filtrates were active.

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Oct. 11.

[1] *Brit. J. Exp. Path.*, 25, 101 : 1944.

## *Ailanthus*, Source of a Peculiar London Honey

THERE can be few beekeepers in the heart of London, and one would not expect the Metropolitan area to be a promising locality for honey production. I therefore welcomed an opportunity of examining a sample of honey from an apiary in Kensington not far from Kensington Gardens, which was brought to my notice in 1943, on account of its unusual flavour. This honey was of a pale greenish-brown colour and after about three months in store set with a fine granulation. The first impression on tasting it was of a mild floral bouquet, but this was followed by a persistent after-taste reminiscent of cats. This flavour recalls exactly the cat-like odour given off by elder flowers (*Sambucus nigra*) when they are drying, and at first suggested that elder might be responsible. The pollens obtained by dilution in water and sedimentation were examined, but *Sambucus* pollen was absent. The most abundant, forming 44 per cent of the total, came from the Tree of Heaven, *Ailanthus altissima*, which is common as a street tree in Kensington. This species is diœcious, and the male flowers, especially, have a strong rather unpleasant odour recalling that of elder. A second major constituent was the sweet chestnut, *Castanea sativa*, the flowers of which also have a strong unpleasant aroma.

The fact that the peculiar after-taste is attributable to the *Ailanthus* was confirmed by the examination of a 1944 honey sample from the same apiary. In this (see table) *Ailanthus* pollen again preponderates, but *Castanea* forms rather less than 4 per cent of the total. The other major constituent in this season was privet, *Ligustrum vulgare*, which yields a coarse-flavoured honey, but this is of not uncommon occurrence and it is not responsible for the after-flavour.

POLLEN ANALYSES OF KENSINGTON HONEYS. THE FREQUENCY OF THE MAIN CONSTITUENTS IS EXPRESSED AS A PERCENTAGE OF THE TOTAL NUMBER OF POLLEN GRAINS.

| Pollen type | Season | |
|---|---|---|
| | 1943 | 1944 |
| Tree of Heaven, *Ailanthus altissima* | 44·0 | 37·7 |
| Sweet chestnut, *Castanea sativa* | 26·0 | 3·7 |
| Privet, *Ligustrum vulgare* | 6·2 | 28·8 |
| Limes, *Tilia* spp. | 6·6 | 4·0 |
| Willow herb, *Epilobium angustifolium* | 0·6 | 8·8 |
| Horse chestnut, *Aesculus Hippocastanum* | 0·6 | 1·7 |
| Miscellaneous pollens | 16·0 | 15·3 |
| | 100·0 | 100·0 |

Beekeepers are apt to attribute unpleasant flavours of unknown origin to the presence of honeydew in the honey. Off flavours from this cause are due not to the honeydew itself but to the sooty moulds that grow in it. Several fungi are concerned, probably the most abundant in Great Britain being *Cladosporium herbarum*. On the evidence of the sooty mould spores, there was very little honeydew in the honeys under review, the mould spores being 5·0 and 9·1 per cent as numerous as the pollen grains in 1943 and 1944 respectively.

The cat-like odour of elder flowers is lost when they are quite dry, and gives way to a pleasant aroma. In addition to medicinal and cosmetic uses, the flowers have been employed in food products to impart a muscatel flavour. The substances responsible for this flavour presumably are derived from the unpleasant smelling constituents of the essential oil. The nature

of the changes taking place in the oil is not mentioned in the literature, though oxidative changes may be involved. Bearing this in mind, the 1943 honey was tasted from time to time, and it was found that the cat-like flavour gradually faded and gave way to a muscatel flavour of increasing intensity. By July 1944, the cat-like flavour had disappeared entirely, leaving a delicious rich muscatel flavour. Honey is usually eaten within a short period of its production, but as with wines and cheeses it would pay to store some kinds until the flavour matures. This applies to *Ailanthus* and *Castanea* honeys, the latter also losing its strong flavour on keeping, and possibly other ill-flavoured honeys that a beekeeper would feed back to his bees in disgust.

*Ailanthus* honey does not appear to have been recorded hitherto from Great Britain, although it has been reported from time to time from other countries. Zander[1], for example, mentions a sample which he describes as having a strong peculiar flavour recalling muscatel; evidently this was not fully matured. I am indebted to Mr. A. Chesnikov for the honey samples.

RONALD MELVILLE.

Royal Botanic Gardens,
Kew.

[1] Zander, E., "Pollengestaltung und Herkunftbestimmung bei Blütenhonig" (Berlin, 1935).

## Larval Growth-Stages of *Agriotes sputator*

THE analysis of wireworm populations has been impeded by lack of knowledge of the number of growth-stages through which wireworms pass during their larval life. In the course of a study of wireworm larvæ, I have found that the growth-stage to which any larva belongs can be determined by counting the number of teeth on the borders of the spiracles.

There are eight growth-stages, and the average number of teeth per row for each stage is as follows: on the thoracic spiracles, I, 3–4; II, 4·5–6; III, 6·75–9·75; IV, 10·5–14·25; V, 15·25–20·75; VI, 21·5–30·5; VII, 32·5–40·5; VIII, 42–62; and, on the abdominal spiracles, I, 0·25–2; II, 2·75–4; III, 4·5–6; IV, 6·75–9·25; V, 9·75–13·75; VI, 14–19·5; VII, 20–28·5; VIII, 29·25–39. All the spiracles of 950 larvæ have been examined, and all the larvæ, although collected at different times of the year, fall into these eight groups.

To count the teeth on all the spiracles is too laborious a process for large-scale work, and a method has therefore been devised whereby the growth-stage can be ascertained by examining a minimum number of spiracles while maintaining an accuracy of more than 97 per cent. The quick method is as follows. Count the teeth on the two outer rows of either thoracic spiracle. If the average number per row falls within the ranges of the eight groups given in column 1 of the accompanying table, the growth-stage is determined as indicated. If it does not, count the teeth on the other thoracic spiracle and test the average number of all four rows now counted against the groups in column 2. If the growth-stage remains still uncertain, recourse must be had to the abdominal spiracles, the teeth on one, two or three of which can be counted and tested similarly against columns 3, 4 and 5 of the table. If desirable, the teeth on any abdominal spiracles can be counted first, and columns 3, 4 and 5 consulted. Should this not show to which growth-stage the larva belongs, the thoracic spiracles should then be examined. By this quick method, all the larvæ can be placed in their growth-stages by counting the teeth on no more than five spiracles.

A full account of the investigation is being prepared for publication.

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Aug. 12.

TABLE FOR DETERMINING THE LARVAL GROWTH-STAGES OF THE WIREWORM *Agriotes sputator*.

| Thoracic spiracles | | | | | | Abdominal spiracles | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | 2 | | 1 | | 2 | | 3 | |
| I | 3–3·5 | I | 3–4 | I | 0–2 | I | 0–2 | I | 0–2 |
| II | 5–5·5 | II | 4·5–6 | II | 3–3·5 | II | 2·5–3·75 | II | 2·5–4 |
| III | 7–9·5 | III | 6·75–9·75 | III | 4·5–5·5 | III | 4·25–5·75 | III | 4·3–6 |
| IV | 11–13·5 | IV | 10·5–14 | IV | 7–9 | IV | 6·5–9 | IV | 6·5–9·3 |
| V | 15–19·5 | V | 15–20·75 | V | 10·5–13 | V | 10·25–13 | V | 9·8–13·3 |
| VI | 22–30 | VI | 21·5–29·75 | VI | 14·5–18·5 | VI | 14·25–18·5 | VI | 14–18·8 |
| VII | 32–39·5 | VII | 31·75–40·25 | VII | 20·5–27·5 | VII | 20·25–27·75 | VII | 19·5–27·7 |
| VIII | 42–62 | VIII | 41·75–62 | VIII | 30–40 | VIII | 28·75–40 | VIII | 28·7–40 |

## Reduction by Carbon Dioxide of Susceptibility of Beans to Tobacco Necrosis Viruses

A COMPLICATING factor in the use of the local-lesion technique for estimating the concentration of plant viruses is that a standard inoculum may give widely different numbers of lesions on different leaves. Differences in age of the plant, nutrition, illumination and position of the leaf on the plant can all affect the susceptibility; but it is unknown whether they do so by altering resistance to injury during inoculation, or whether they produce more fundamental changes in the physiology of the injured cells which prevent infection. We have found that exposing plants to atmospheres containing 30–60 per cent carbon dioxide greatly reduces the susceptibility of bean plants (*Phaseolus vulgaris*, var. Canadian Wonder) to tobacco necrosis viruses. As this reduction can be brought about by exposure after inoculation, the effect is presumably due to physiological changes within the cell and not to the number of entry points opened during the inoculation.

The reduction in the number of local lesions depends on the length of exposure to carbon dioxide. To quote one experiment: plants exposed immediately after inoculation for 15, 30, 60 and 120 minutes gave 46, 39, 17 and 13 per cent of the number of local lesions produced on control plants. When plants are exposed for two hours to the gas mixture, they show the same reduced susceptibility whether inoculated with the virus immediately

before or immediately after exposure. The changes responsible for the fall in susceptibility are readily reversed on returning the plants to air, and four hours after exposure to carbon dioxide the treated plants are again as susceptible as untreated controls. Also, plants inoculated for four hours before exposure to carbon dioxide produce as many lesions as control plants.

The effect is unlikely to be a direct inactivation of the viruses, for they are unaffected by long exposure to saturated solutions of carbon dioxide. As exposure is ineffectual four hours after inoculation, it seems that within this time the virus is normally established in tissues where it multiplies, and that some changes in the metabolism of the cell prevent this establishment in the treated plants. Longer exposures than two hours could not be tried as they damaged the plants: even exposure for two hours causes obvious damage unless exposure is made below 10° C. We were, therefore, unable to see if carbon dioxide reversibly inhibits the multiplication of these viruses after they are established, as Woods[1,2] claims that treating plants with potassium cyanide reversibly inhibits the multiplication of tobacco mosaic and tobacco ringspot viruses. Woods attributes this effect to a reversible change in the respiratory system; as carbon dioxide can also reversibly affect respiratory systems of plants, the two phenomena may be related.

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[1] Woods, M. W., *Science*, 91, 295 (1940).
[2] Woods, M. W., *Phytopath.*, 33, 77 (1943).

## *Alternaria Solani* on Tomato

THIS fungus, causing the well-known 'early blight' of potatoes and tomatoes in some countries, has not hitherto been found attacking tomato plants in Britain. There are, however, a few early records, none relating to serious outbreaks, which unfortunately were accompanied by incomplete and inadequate descriptions or by none at all and which, in the light of more recent knowledge of the species, are open to doubt.

In September 1944, in outdoor plantations in Kent and Sussex, this disease was found causing severe leaf and stem spotting to such a degree that, in one instance, a plantation of 1½ acres assumed a withered or 'scorched' appearance. Lesions occurred at the calyx end of the fruits, which started to rot and fall to the ground.

The fungus associated with the disease may be referred to *Alternaria Solani*, and all the symptoms induced on tomato agree fully with those described in other countries.

It has been thought advisable to make this preliminary announcement before the tomato crop of the 1944 season in Britain has been finally dealt with. A paper describing the occurrence in detail has been prepared for publication.

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## Electron Mobility in Large Molecules

IN an earlier paper[1], I discussed the longitudinal and transverse polarizabilities of a number of bonds, as calculated from data on refractivity, Kerr constant and depolarization factor. The C–C single bond was exceptional in having a very high ratio (*c.* 100 : 1) of the longitudinal to the transverse polarizability. This indicates that in this bond the electrons can be displaced much more readily in a direction parallel to the bond than in a direction at right angles. It was suggested that this factor might be of importance in connexion with the structure of long-chain compounds.

It appears now that a number of measurable physical properties—polarizability, charge transfer spectra, colour, fluorescence, electrical conductivity and the Van der Waals' forces—are all closely related and may be of great significance with regard to the chemical and biological properties of large organic molecules.

In a series of papers[2], Mulliken has discussed charge transfer spectra and the effects of hyperconjugation. As the name implies, the charge transfer spectrum arises from transitions from an excited state which has an ionic wave function corresponding to the displacement of electrons within the molecule. The more highly conjugated and the more elongated is the structure, the nearer are the normal and the excited states, and the further the spectrum is pushed towards the visible. There is a corresponding enhancement of refractivity and, if the transitions in question are sufficiently intense, colour may also arise. These properties are particularly well exemplified among the polyenes, and Mulliken has suggested that they are related to the tendency of these molecules to polymerize. In β-carotene, his calculations indicate that an electronic charge oscillates over about 32 per cent of the length of the system of eleven conjugated double bonds.

In his theory of the dispersion forces, London[3] has shown the connexion between polarizability and the Van der Waals' forces. In a later paper[4], he has used my anisotropic bond polarizabilities and has also considered the forces between large molecules containing extended electronic oscillators. These forces ('monopole forces') are highly specific and no longer additive. Their range extends far beyond that of the ordinary Van der Waals' forces of small molecules, and this may be of significance in connexion with rubber-like elasticity and the aggregation of polymeric molecules into fibres. The forces are particularly strong in the case of conjugated systems, where the electronic oscillators are of considerable length and of relatively low frequency. Moreover, with regard to electrical conductivity, such a system "... forms something like a miniature piece of metal ...".

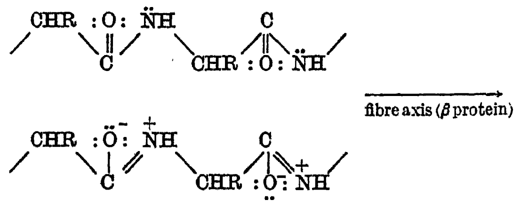
The connexion between polarizability and electrical conductivity had also been noticed by Herzfeld[5]. Among the elements, electrical conductivity is attained when the polarizability, as measured by the refractive index, reaches a critical value equal to the cube of the atomic radius. Weiss[6] has discussed fluorescence and the approach to metallic properties[7] among highly conjugated and carcinogenic hydrocarbons. In graphite, the conjugation reaches a very high level: there is appreciable conductivity, and metal-like salts can be obtained. In these, the anions

(for example, $HSO_4^-$, $ClO_4^-$) lie between the lattice planes of the graphite.

The high electron mobility in conjugated systems, arising from the delocalized $\pi$ orbitals, thus gives rise to very distinctive properties. Moreover, Mulliken has shown that a certain degree of conjugation ('third order' conjugation or 'hyperconjugation') exists even in fully saturated organic molecules. Hyperconjugation is a delocalization effect whereby C–H bonds tend to donate electrons to C–C and other bonds, and this is found to be a stabilizing influence in all organic molecules. It would appear, therefore, that there is an incipient injection of electrons into the chain and a certain degree of longitudinal electron mobility (quasi-conductivity) in any organic system. This effect is much increased whenever multiple bonds are also present. In this connexion, Bateman and Jeffrey[7] have recently observed a significant degree of bond shortening (to 1·43 A.) in the central bond of a 1 : 5 diene (geranylamine hydrochloride).

Mulliken has suggested that C=O groups can give rise to a very energetic type of hyperconjugation. Shortening has been observed in the C–C bonds in $CH_3.CHO$ (to 1·50 A.)[8] and in oxalic acid (to 1·43 A.)[9].

A system of this type is the polypeptide grid of the proteins in which the C=O bonds are in the 1 : 5 position to each other. Two alternative formal bond structures can be written as follows (see also Huggins[10]).




This system would be expected to have an appreciable electron mobility over the full length of the molecule and along the axis of the protein fibre. This may be of importance in connexion with the activity of nerve and muscle. By contrast, the fibres of plants, in which there is no nervous system of the type existing in animals, is based on cellulose. In this substance, opportunities for conjugation are much smaller than in protein. Cellulose fibres would thus be expected to show a lower electrical and optical activity and a higher chemical stability than corresponding fibres based on protein.

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[1] Denbigh, *Trans. Faraday Soc.*, **36**, 936 (1940).
[2] Mulliken, *J. Chem. Phys.*, **7**, 14, 20, 121, 339, 353, 356, 364, 570 (1939); **8**, 234, 382 (1940). *J. Amer. Chem. Soc.*, **63**, 41, 1770 (1941).
[3] London, *Trans. Faraday Soc.*, **33**, 8 (1937).
[4] London, *J. Phys. Chem.*, **46**, 305 (1942); see also *C.R.*, **208**, 2059 (1939).
[5] Herzfeld, *Phys. Rev.*, **29**, 701 (1927).
[6] Weiss, *Nature*, **145**, 744 (1940).
[7] Bateman and Jeffrey, *Nature*, **152**, 446 (1943).
[8] Stevenson, Burnham and Schomaker, *J. Amer. Chem. Soc.*, **61**, 2922 (1939).
[9] Robertson, J. M., *J. Chem. Soc.*, 131 (1938).
[10] Huggins, *Chem. Rev.*, **32**, 195 (1943).

## Red Stannous Oxide

A CENTURY ago, Fremy[1] and Roth[2] described the preparation and properties of red forms of stannous oxide. More recently, Bury and Partington[3] and Weiser and Milligan[4] were unable to obtain these. The matter seemed worth investigating again in the light of a paper by Ehret and Greenstone[5] on red zinc oxide.

In work still in progress, it has been found possible to obtain products in all respects identical with those described by Fremy and by Roth, though by slightly different experimental procedures.

Fremy's method of preparation was modified by precipitating a solution of stannous chloride, containing hydrochloric acid, with excess of aqueous ammonia, heating the resulting thick suspension of stannous hydroxide for some time on the water bath, and finally evaporating thin, even films of the suspension to dryness in large porcelain dishes. After repeatedly decanting with boiled distilled water, and drying in vacuum, a deep orange powder is obtained.

Roth's oxide was obtained by heating a suspension of stannous hydroxide in very dilute acetic acid in presence of sodium hypophosphite. The product is deep crimson and of larger grain size than that obtained by Fremy's method.

The presence of free tin in the red oxides could not be established by amalgamation or by conductivity measurements. X-ray diffraction powder photographs taken with cobalt $K\alpha$ radiation showed the patterns from the two red oxides to be identical, but different from those of normal tetragonal stannous oxide and of stannous hydroxide.

The red stannous oxide appears, therefore, to be a distinct crystalline modification.

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[1] Fremy, *C.R. Acad. Sci.*, **15**, 1108 (1842); *Ann. Chim. Phys.*, (3), **12**, 460 (1844).
[2] Roth, *Jahrb. der prakt. Pharm.*, **10**, 381 (1845).
[3] Bury and Partington, *J. Chem. Soc.*, **121**, 1998 (1922).
[4] Weiser and Milligan, *J. Phys. Chem.*, **36**, 3039 (1932).
[5] Ehret and Greenstone, *J. Amer. Chem. Soc.*, **65**, 872 (1943).

## Mr. F. Lincoln and the Cavendish Laboratory

MR. F. LINCOLN, who has been on the staff of the Cavendish Laboratory for fifty-four years and has been laboratory steward since 1902, retired on September 30. Generations of research students have passed through the Laboratory during the years of Lincoln's reign, and he is widely known to physicists throughout the British Empire and in other countries.

We are making him a presentation to mark our gratitude for his long and devoted service to the Laboratory, and I have written to past and present Cavendish men inviting subscriptions. There must, however, be many whom I have not been able to reach by a letter, and I would be glad to receive contributions from readers of *Nature* who wish to be associated with this gift to Mr. Lincoln.

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# SUITABILITY OF A COOL MARITIME CLIMATE FOR SEED POTATO PRODUCTION

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DURING a survey of the South African coastal areas, a test was devised for deciding if the climate of a maritime area was suitable for growing seed potatoes. It needs only the simplest apparatus, and has both practical and theoretical advantages over the current method of aphid surveys, which it might well supplement or replace.

In the seed potato areas of maritime climates—and we are concerned here with no other—freedom from the aphids which spread virus diseases depends, Davies[1,2] showed, on conditions which check their flight. These conditions are low temperature, high relative humidity, and wind. Wind will be considered later. The temperatures and humidities which are specially relevant are those during the warmest part of the day when aphids most readily take to the wing. Suitable limits of temperature are determined fairly easily. Actual reference to good seed areas suggests that the average daily maximum temperature for June, when migration normally occurs from winter hosts to potatoes, should not greatly exceed, and should preferably be somewhat less than, 65° F. It is the factor of relative humidity which has been the stumbling block. Records at the warmest part of the day are often not available. Davies[3] resorted to records for 9 a.m. in his survey of the Scottish areas. This is unfortunate. It implies without warrant a small rise in temperature during the day, for it is only in climates with small daily ranges of temperature that one can rely upon high relative humidities in the morning persisting for the rest of the day.

Paradoxically, one may dispense altogether with records of relative humidity as a measure of the humidity factor, and concentrate solely on the need for a small daily range of temperature. A small range ensures not only that the drop in relative humidity during the day is small, but also that the level of humidity is high, in the sense that small daily ranges are characteristic of climates in which moisture is abundant enough greatly to restrict the daily change of temperature by radiation. The relation between the relative humidity at the warmest time of the day and the daily range of temperature depends largely on latitude, season and climate; but our problem can be simplified by restricting it to finding what is a suitable daily range in a zone between fairly narrow limits of latitude, during a single month, June (or December in the southern hemisphere), in a cool maritime climate in which the mean maximum temperature for this month is about 65° F. or somewhat less. We can do this empirically, by referring to successful seed areas. The evidence which follows is that the daily range for June (measured as the difference between the mean maximum and mean minimum temperatures for the month) should be less than about 13° F. for a good area; that a range of 16° F. or more indicates unsuitability for seed; and that between these limits lie doubtful cases and, probably, cases in which the established meteorological stations are not exactly representative of the potato fields in the district.

In the western counties of Eire, where the dangerous aphid, *Myzus persicæ*, is extremely rare on potatoes[4], the daily range averages 11·4° F.[5]. In Scotland the areas found by Davies[3] to be nearly free from *M. persicæ* have an average range of 12·9° F. (Montrose, 13·7° F.; Banff, 11·6° F.; and Fortrose, 13·4° F.), while in the poor seed areas the average is 16·2° F. (Dundee, 16·9° F.; Edinburgh, 13·4° F.; Perth, 18·3° F.; and Cupar, 16·3° F.). In North Wales the range is 8·1° F. at Holyhead (Anglesey), where *M. persicæ* has been consistently scarce[6,7]; 13·1° F. at Aber (North Caernarvonshire), a 'moderately' good area[7]; and 16·5° F. at Sealand (Flintshire), a poor area for seed[1]. In Cornwall and Devon, to judge by the scant number of meteorological stations in the official list[5], the areas chosen by Staniland[8] for seed have a range of about 10·9° F. (Ilfracombe, 10·6° F.; Woolacombe, 10·0° F.; Bude, 12·8° F.; Newquay, 10·2° F.). Many areas were rejected by Staniland for reasons irrelevant to this discussion (presence of eelworm, proximity to market gardens, etc.); taken on the whole, *M. persicæ* is scarce over most of Cornwall, and the daily range is small, averaging 12·2° F. for the seven stations in the official list. By contrast, to give on a large scale an example of an area where *M. persicæ* is generally abundant in potato fields, the daily range at thirty-four stations in the English Midlands varies from 15·0° F. to 19·8° F., with an average of 17·6° F.; and similar high ranges are usual in all English and Welsh counties which, in Samuel's map, are shown to get more than 25 per cent of their seed from Scotland or Ireland. Finally, to take an example from the relatively small part of the United States with a cool maritime climate, Eureka, on the Californian coast, is a good seed area (M. R. Harris *in litt.*), and has a daily range of 9·2° F.

The criteria we have adopted—a mean maximum temperature about 65° F., or less, and a daily range of 13° F., or less, during June—are for readings taken in a Stevenson screen at the usual height above short grass. In applying the test to any site one is ultimately concerned with averages over many years, but in practice substantial accuracy may be possible in a single season by determining from old-established meteorological stations in the neighbourhood what correction must be made for seasonal abnormality.

Because it uses only a maximum and minimum thermometer and a Stevenson screen and because of the ease of taking readings, which any intelligent farmer could do, the test meets the need for surveys in enough detail to take into account local physical features (particularly aspect, altitude, and exposure to sea-winds) which greatly affect climatic suitability for seed production; and one hopes that the end of the War will see the release of enough meteorological apparatus to allow surveys to be started without delay. Existing records tell in broad outline what land is worth surveying. In South Africa, for example, a really suitable maritime climate is limited to a narrow barren strip along the west coast. In England and Wales sites with daily ranges not greater than 13° F., and mean maximum temperatures not above 65° F. during June are most likely to be found in the Isle of Man; Anglesey; Caernarvonshire; the western half of Merionethshire, Cardiganshire, and Carmarthenshire; Pembrokeshire; the western tip of Glamorganshire; Devonshire, especially the north to a depth of about fifteen miles from the coast, and to a lesser extent the south coast; Cornwall; the coast of Dorsetshire; and areas of varying depth along the

south and east coast from Hampshire (especially the Isle of Wight) to Norfolk. Whether conditions other than climate are suitable in these areas is beside our point.

Temperatures during June do not adequately explain variations in the prevalence of *M. persicæ* from year to year. These variations are closely linked with conditions during winter[7,10]. Thus, in Cornwall and Devon the very hard winter of 1939–40 greatly reduced the numbers of *M. persicæ*, and the potato crop which followed was lightly infested[8], even though the summer of 1940 was unusually hot and dry. But very cold winters are not characteristic of *maritime* seed areas. The contrary is demonstrably the case. To take as examples places in North Wales which have already been cited, minimum temperatures during January are higher at Holyhead than at Aber, and at Aber than at Sealand; while, to illustrate on a larger scale, the general run of winter minima is appreciably higher in the good seed areas of Ireland, North Wales and south-western England than in the English Midlands, and at least as high in the Scottish seed areas as in the Midlands[5].

Because they carry the taint of interference by irrelevant winter temperatures, aphid surveys in maritime climates must often be continued tediously for many years if they are to be sound. But speed is not the only advantage of the June temperature test. It is unaffected by the often remediable proximity of Brassicæ or other winter hosts. Further, being a test of the climatic conditions which govern the flight of *M. persicæ*, it measures the tendency towards migration; and the number of winged migrants to potato fields is, Whitehead[7] believes, a finer test of the aptness of an area for seed than the crude total of aphids, mostly wingless, which eventually multiply in the fields and are ordinarily the subject of a survey.

Wind has not been discussed, because its independence as a separate factor is questioned. It is true that Davies[2] showed in the laboratory that wind (above 3·75 m.p.h.) stopped the voluntary flight of aphids, but this does not imply that all wind is beneficial. In the maritime type of seed area a hot dry wind would be out of place and counter to the need for a cool temperature and a high relative humidity. All we can consider as unquestionably beneficial are cool, moist winds which, in the type of area under discussion, we can for all practical purposes take to be sea-winds. Their prevalence needs no elaborate system of wind roses for its measurement; it can be recognized simply by the intensity of the maritime influence on the climate, as determined, among other methods, by the June temperature test. In support of this view is the recognized fact that mere bleakness and high altitude are no adequate substitute for exposure to the sea.

The test applies only to a cool, maritime climate, and it would save confusion to point out that such a climate is only one of at least three in which infestation of potatoes by *M. persicæ* can be controlled naturally. The bulk of the world's seed potatoes is grown in areas with a cold, continental winter. These include most of the seed areas of continental Europe, of continental North America and (because the weather there moves from west to east) even most of the Atlantic seaboard of the United States and Canada. In these areas the requirements for good seed are very different. Finally, *M. persicæ* is scarce on potatoes in a very hot, dry climate, a fact systematically exploited in South Africa[11]. Here the desirable features are the opposite of those in a cool maritime climate: a mean maximum temperature during the summer months of about 90° F., a daily range of 28°–35° F. or more, and strong, hot, dry land-winds.


[1] Davies, W. M., *Ann. Appl. Biol.*, **22**, 106 (1935).
[2] Davies. W. M., *Ann. Appl. Biol.*, **23**, 401 (1936).
[3] Davies, W. M., *Ann. Appl. Biol.*, **26**, 116 (1939).
[4] Davidson, W. D., *J. Dept. Agric. Eire*, **35**, 20 (1935).
[5] Averages of temperatures for the British Isles for periods ending 1935. Met. Office (Great Brit.) H.M. Stationery Office.
[6] Davies, W. M., *Ann. Appl. Biol.*, **21**, 283 (1934).
[7] Whitehead, T., *Ann. Appl. Biol.*, **30**. 85 (1943).
[8] Staniland, L. N., *Ann. Appl. Biol.*, **30**, 33 (1943).
[9] Samuel, G., *Ann. Appl. Biol.*, **30**, 80 (1943).
[10] Thomas, I., and Jacob, F. H., *Ann. Appl. Biol.*, **30**, 97 (1943).
[11] *Nature*, **153**, 589 (1944).


# ONTARIO RESEARCH FOUNDATION

ACCORDING to the report of the Ontario Research Foundation for the year 1943, that year saw a peak in the activities of the Foundation; for the first time since 1928 the problem of allotting laboratory space became acute. Some decision as to whether increased or permanent extensions are justified will be required in the near future. A second limiting factor has been the supply of trained research workers; until the demands from military departments and the war industries diminish, it will be impossible to devote adequate and sustained attention to post-war problems. The transition period might be shortened if research relating to post-war problems were given a higher rating in the system of controls and restrictions. It was not until shortly before the present War that any considerable use was made of the Foundation's facilities other than for routine services and short-term investigations, and at present the Foundation cannot establish enough fellowships to take care of the demand for research. This change is largely due to the gradual development and diffusion of a correct understanding of the relation between industrial scientific research and economic stability. It would add greatly to the stability and continuity of scientific research if the Governments concerned would encourage and not disallow the establishment of reserves for research.

The services of the Department of Engineering and Metallurgy have been almost wholly engaged on research or production associated with the War. The Gauge-Testing Laboratory has operated with approximately the same staff as in recent years. The gauges now being submitted by the inspection board of private manufacturers require steadily increasing skill and accuracy. The important contribution of the Physical Testing Laboratory is indicated by the increase in the number of test reports sent out from 350 in 1940 to 3,200 in 1943. The facilities have been improved by the addition of a 10,000-lb. tensile testing machine. The Heat-Treatment Laboratory handled 70 per cent more work than in the previous year. The general testing and short-term studies of the Textile Department slightly decreased. There exists in Canada a definite need for standards for moisture content of textiles, based on Canadian conditions of climate, and for an independent laboratory equipped to perform this service and issue certificates which will generally be accepted. A suggestion was made during the year that the Foundation should equip such a laboratory for testing wool

tops, but owing to the shortage of trained men response to the idea has not been possible. The process developed for setting the twist in rayon yarns has been in successful operation throughout the year, and a possible extension to the 'Nylon' field after the War is anticipated. Textile oils developed in the Department met all the requirements of the industry in plant trials. There is evidence that the consumer demand for quality-controlled goods is increasing.

The Department of Biochemistry has investigated on a pilot-plant scale some processes for producing glycerol from wheat, and the study of methods for hydrogenating linseed oil to plastic shortening has continued. The Vitamin Laboratory continues to study and evaluate the latest suggestions for determining quantitatively various vitamins in foods, and a study is in progress to determine the minimum amount of protein required to maintain rats in good health when the diet is adequate in all other respects. Research on synthetic rubber has been co-ordinated with that of the Canadian and American Rubber Committees. The possibilities of raising the quality of Buna *S* by addition of small amounts of chemicals to standard butadiene–styrene mixtures have been explored.

The Department of Agriculture has now collected all the material for a detailed map of the physiography of Southern Ontario, and has found that the photographs of the Royal Canadian Air Force offer a rapid method of obtaining accurate boundaries of physical land features. A thorough search has been made of geological literature relating to this and similar areas in preparation for writing a monograph of the physiography. A detailed study of regional agriculture in Old Ontario was continued; and in the Pathology Laboratory research was continued on problems associated with *Ascaris lumbricoides* infection of hogs, using guinea pigs in the experimental work, as well as on the blood parasites of ruffed grouse.

## SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

### ANNUAL CONGRESS

THE South-Eastern Union of Scientific Societies held its forty-ninth annual congress at High Wycombe on October 14—a single day of sessions and excursions attended by sixty representatives and members. It was organized by the Buckinghamshire Archæological and Architectural Society.

A representative assembly to transact the business of the seventy constituent societies was held in the Royal Grammar School, founded by the Knights of St. John and Jerusalem. For the ensuing year, Brigadier F. A. E. Crew was inducted as president of the Union. After many years as professor of animal genetics in the University of Edinburgh, he has recently been appointed to the Bruce and John Usher chair of public health at Edinburgh; and he is now serving at the War Office as director of biological research; his address was appropriately devoted to "The Biology of War". At the Guildford Congress in 1942, Dr. J. Ramsbottom in his address upon a similar theme (*Nature*, **150**, 241; 1942) came to the conclusion that "Competition in modern man is, for the most part, sociological and not biological". Brigadier Crew considers that "most of the causes of war have their origins, not in the biological constitution of man, but in the constitution of the social aggregates which man has formed and fashioned". Industrialized societies produce so full a routine of work which the ordinary man must carry out to earn a living that war may be welcomed for its stimulating excitement and loosening of conventional bonds. In brief, war is a great adventure because social conventions have not made an adventure out of peace. It is doubtful whether modern war is eugenically selective. "The lethality of a missile propelled from a gun or dropped from the skies has no relation whatsoever to the biological qualities of the man who releases it, and the winning of a combat or of a war is no proof of the biological superiority of the victor". There is a school of thought which teaches that war is definitely dysgenic. Possibly the flower of a generation is destroyed by war, but the flower is not so important as the seed and there is no proof that casualties in the War of 1914–18 seriously affected the physique of the present combatants. "Final victory in war rests with that contestant whose population is caused to increase more rapidly as the result of it." The present groups of mankind represent two widely different ideologies and cultures; it may matter very much indeed to humanity generally, for the next few generations at least, which of these shall prevail.

At the sectional sessions the following papers were read: "The Evolution of the Dwelling House", by E. Yates; "Archæological Work in Bucks", by Flight-Lieut. E. Clive Rouse; "Fungi as Food", by Dr. J. Ramsbottom; "Man and the Migration of Phosphorus", by Dr. K. P. Oakley; "A Plan for Local Social Science Workers", by A. Farquharson; and "The Fauna of New Guinea", by Miss L. Evelyn Cheesman.

In the afternoon, E. A. L. Martyn conducted a walk around Chipping Wycombe of interest to archæologists; naturalists visited Hughenden Valley, and others were shown the geological features of the district.

The annual congress is normally held in June, but this year it had to be postponed until the autumn as the original proposal to hold it in July at the Slough Social Centre proved impracticable. T. D.

## CURRENT MEASUREMENT AT VERY HIGH FREQUENCIES

A PAPER by G. F. Gainsborough entitled "Experiments with Thermocouple Milliammeters at Very High Radio Frequencies" (*J. Inst. Elect. Eng.*, **91**, Part III, No. 15; Sept. 1944) describes work conducted at the National Physical Laboratory under the auspices of the Radio Research Board. In order to assess the performance of commercial thermocouple milliammeters at frequencies up to 700 Mc./s., a reference standard air-milliammeter was first developed by the author, following principles first described by J. A. Fleming in 1910. Each of two similar air cells connected by a capillary tube with a liquid index contains a resistive wire which can be heated either by an alternating or direct current. With a capillary tube of 1 mm. bore, and using a low-power microscope to observe the index, the apparatus described in the above paper gave readings of current of the order of 10 mA., which could be reproduced with an accuracy of 1 part in 1,000. The sensitivity

could be altered by using capillaries of different bore, and filaments of different resistance.

With the aid of this instrument as a reference, an examination was made of some ordinary commercial vacuo-thermocouple milliammeters, in which the heaters are made of various well-known resistance alloys, and the thermocouple is separated electrically from its heater. One type of instrument tested contained a heater of one of the nickel-chromium-iron alloys; and a calibration of this instrument showed that its readings were subject to errors of more than 25 per cent for currents of less than half the maximum, this error falling relatively sharply to about 1 per cent over the top third of the current range. An investigation of this phenomenon showed that the material of which the heater wire was made was ferromagnetic at room temperature, but that the Curie point occurred at about 70° C., which was well within the working temperature range of the heater when supplied with its normal current. A simple method of examining the magnetic properties of the heater wire provided a confirmatory demonstration of this effect, and also enabled other samples of wire to be selected with the Curie point outside the working temperature range. When some new thermocouple milliammeters containing heaters of this alternative material were calibrated against the air milliammeter at a frequency of 100 Mc./s., the readings of the new instrument were indistinguishable from those of the standard.

With the aid of the experience gained in this work, various patterns of vacuo-thermocouple instruments were designed for higher frequencies. Considerable care was necessary in arranging the calibrating apparatus; but the results showed that for the new instruments, which were made on a commercial basis, the calibration at 700 Mc./s. agreed with the low-frequency calibration within the limits of experimental error, which was not more than 1 per cent of the maximum current.

In the concluding section of his paper, the author points out that when two such instruments are connected in series as closely together as possible, their readings usually differ widely when the circuit containing them is supplied with current at 700 Mc./s, unless some unusually great precautions are taken. It is suggested that, in practice, the opportunities of applying such devices usefully as milliammeters will be few at frequencies greater than 100–200 Mc./s. Nevertheless, instruments of the types described will have wide applications of relative signal magnitude at higher frequencies, and they may also have an important use as milliwattmeters.

## WEST CUMBERLAND AND ITS UTILIZATION

THE industrial region of West Cumberland coincides in the main with the coalfield and has its foci in the ports of Whitehaven, Workington and Maryport. With a total population of 150,000, there were 35,340 insured persons in 1932 and 36,870 in 1937. Out of the 1932 total, no less than 15,577, or nearly 45 per cent, were unemployed, and West Cumberland was scheduled as a depressed or 'special' area by the Special Areas Act of 1934. A careful and detailed study[1] by Prof. G. H. J. Daysh (at present directing the regional research work of the Ministry of Town and Country Planning) has surveyed the rise and fall of the chief industries and serves to emphasize the overwhelming dependence on coal-mining, iron and steel—industries which were especially affected by the depression of the 'thirties. The activities of the Special Areas Commissioner, Mr. E. G. Sarsfield-Hall, aided by the West Cumberland Development Council, were accordingly directed towards securing a diversification of industry and particularly to attracting light industries able to employ the available female labour.

The War has seen not only a return of prosperity to the old industrial centres but also has witnessed the building of vast works in hitherto untouched country, thus extending very considerably the former industrialized area. The problem for the future is thus of even wider import than it was in 1939. In the White Paper on Full Employment, the Government has accepted the recommendations of the Barlow Commission relating to dispersal of industry, and it is almost certain that West Cumberland will be constituted a 'Development Area' in which the Board of Trade, as the responsible Ministry, will encourage industrial development. The appearance of a cyclostyled report[2] by a business man and practical engineer whose companies have works in the area is thus opportune, and in his plan Mr. W. C. Devereux suggests industries which will provide employment for an additional 9,145 persons (compared with 18,615 estimated to be required by existing industries). The new industries proposed fall into three groups: (*a*) textiles, including wool and rayon; (*b*) engineering and skilled metal work; (*c*) canning and processing of agricultural produce.

It is, unfortunately, far from obvious that the basic causes of depression in West Cumberland have been realized. With the development of electric power, industry, even heavy industry, is no longer tied to the coalfields, with the result that transport facilities have become the dominant factor in industrial location. Broadly speaking, West Cumberland is at the end (apart from limited sea-traffic through the ports) of a branch line both of railway and road from Carlisle, and the obvious location for new industry is Carlisle rather than the coalfield, since Carlisle is on a main route with Scottish markets on one hand and English on the other. The advocates of a main through west coast road, crossing the head of Morecombe Bay by a viaduct, have recognized the importance of placing West Cumberland on a main through road route with direct access to Lancashire. Incidentally, such a road would open up to tourist traffic the delightful stretch of coast, with its magnificent views of the Lakeland mountains, from Millom to St. Bees Head.

Physical planning is essentially the right allocation of land for all the varied needs of the nation, and the advent of the much criticized Board of Trade into the field of post-war planning creates many problems. The West Cumberland development area overlaps the proposed national park, and there is no doubt that if encouragement is given to the continuance of industry in some of its war-time locations, then the enormously important influx of wealth from holiday visitors will cease. Seaside holiday homes are at present occupied by munition workers: only a central planning authority can decide their rightful future use in the national interest.

L. DUDLEY STAMP.

[1] "West Cumberland (with Alston), A Survey of Industrial Facilities". (Whitehaven: West Cumberland Development Council, Ltd., 1938.)

[2] "An Industrial Plan for West Cumberland, 1944." By W. C. Devereux. (Slough: High Duty Alloys, Ltd., Trading Estate.)

# FORTHCOMING EVENTS

### Saturday, November 18

QUEKETT MICROSCOPICAL SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Papers.

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield, 1), at 2.30 p.m.—Mr. R. A. Hacking: "Technical and Economic Problems in the Heavy Iron and Steel Industry".

### Monday, November 20

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Prof. E. Capstick: "Milk", (1) "Dairy Education and Technological Training" (Cantor Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Effect of Welding on Electricity Supply" (to be opened by Dr. H. G. Taylor).

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S.W.7), at 8 p.m.—Mr. S. H. Beaver: "Minerals and Planning".

### Tuesday, November 21

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Prof. Daryll Forde: "Social Development in Africa and the Work of the International African Institute".

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 5.15 p.m.—Mr. F. C. Bawden: "Plant Viruses and Virus Diseases", (i) "The Behaviour of Viruses in Infected Plants".

INSTITUTION OF CIVIL ENGINEERS (RAILWAY ENGINEERING DIVISION) (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. Hugh O'Neill: "Metallurgical Studies of Rails".

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "New Aspects of Post-War Interference Suppression" (to be opened by Mr. P. R. Coursey).

### Wednesday, November 22

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Prof. I. M. Heilbron, F.R.S.: "The New Insecticidal Material D.D.T." (Aldred Lecture).

INSTITUTE OF FUEL (MIDLAND SECTION) (at the James Watt Memorial Institute, Birmingham), at 2.30 p.m.—Mr. A. Stirling: "The Practical Aspects of Reheating and Heat Treatment Furnace Insulation".

PHYSICAL SOCIETY (COLOUR GROUP) (in the Physics Department of the Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 3.30 p.m.—Mr. E. N. Willmer: "Retinal Structure and Colour Vision".

INSTITUTE OF FUEL (NORTH-WESTERN SECTION) (joint meeting with the LIVERPOOL ENGINEERING SOCIETY) (at the Municipal Annexe, Dale Street, Liverpool).—Dr. A. C. Dunningham and Mr. B. M. Thornton: "Mechanical Stokers for Shell Type Boilers" (Précis and Discussion).

### Thursday, November 23

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 2.30 p.m.—Prof. James Gray, F.R.S.: "Locomotory Mechanisms in Vertebrate Animals", (i) "Aquatic Locomotion—Fins as Propellers, Brakes and Mechanisms of Directional Control".

LINNEAN SOCIETY OF LONDON (joint meeting with the ZOOLOGICAL SOCIETY OF LONDON) (at Burlington House, Piccadilly, London, W.1), at 3.15 p.m.—Dr. Maria Skalińska: "Polyploidy in *Valeriana officinalis* Linn. in relation to Ecology and Distribution"; Mr. R. Winckworth: "From Linnaeus to Lamarck": Prof. F. Wood-Jones, F.R.S.: "Time and Lamarck" (the Discussion on the Lamarck papers will be opened by Prof. J. B. S. Haldane, F.R.S.).

PHYSICAL SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. M. N. Saha, F.R.S.: "A Physical Theory of the Solar Corona".

### Thursday, November 23—Friday, November 24

IRON AND STEEL INSTITUTE (at the Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1).—Discussion on "Blast Furnace Operation and Problems".

**Thursday, November 23**

At 11.30 a.m.—Discussion on Fuel Consumption.

At 2.45 p.m.—Discussion on Furnace Operation and Problems.

**Friday, November 24**

At 10.30 a.m.—Discussion on the Preparation of the Burden (with special reference to Ore Beneficiation and Sinter).

At 11.45 a.m.—Discussion on Refractories.

### Friday, November 24

PHYSICAL SOCIETY (OPTICAL GROUP) (in the Physics Department of Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 2.30 p.m.—Mr. E. Wilfred Taylor: "Notes on the Evolution of the Inverting Eyepiece"; Instructor-Captain T. Y. Baker: "Achromatism of two Thin Separated Lenses and of a Cemented Doublet"; Mr. B. K. Johnson: "A New Modification of a Ray Plotter" (demonstration).

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 5 p.m.—Dr. E. F. Armstrong, F.R.S.: "The Gas Industry—Yesterday and Tomorrow".

INSTITUTION OF MECHANICAL ENGINEERS (in conjunction with the MANUFACTURE GROUP) (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. C. A. Gladman: "Drawing Office Practice in relation to Interchangeable Components".

INSTITUTE OF FUEL (SCOTTISH SECTION) (at the Royal Technical College, Glasgow), at 5.45 p.m.—Dr. W. Reid: "The Mining of Coal".

### Saturday, November 25

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (joint meeting with the SCIENTIFIC AND TECHNICAL GROUP OF THE ROYAL PHOTOGRAPHIC SOCIETY) (at 16 Princes Gate, South Kensington, London, S.W.7), at 3 p.m.—Mr. G. Parr: "The Electron Microscope"; Dr. E. M. Crook and Mr. L. V. Chilton: "Photographic Materials for use in the Electron Microscope"; Dr. D. G. Drummond: "Applications of Electron Micrography in Textile Research".

# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHEMICAL ENGINEER by an important Engineering Company in the Midlands—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2195.XA) (November 28).

SCIENTIFIC OFFICER (temporary) to take charge of the MATHEMATICAL and COMPUTATIONAL WORK of the Admiralty Computing Service—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. A.702.A) (November 28).

WATER ENGINEER—The Clerk to the Trowbridge, Melksham and District Water Board, 22 Silver Street, Trowbridge (endorsed 'Water Engineer') (November 30).

SPEECH THERAPIST—The Director of Education, Education Office, 8 City Square, Dundee (December 1).

DEMONSTRATOR IN HUMAN PHYSIOLOGY, and an ASSISTANT KEEPER to be responsible for the Zoological Collections in the Manchester Museum—The Registrar, The University, Manchester 13 (December 1).

ENGINEER (Water Supplies) by the Gold Coast Government Public Works Department—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.1094.A) (December 11).

AGRICULTURAL SCIENTIFIC OFFICERS (temporary) on the staff of the National Institute of Agricultural Engineering, Yorks.—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.3066.A) (December 11).

GEOPHYSICIST (temporary), a GEOLOGIST (established), and a GEOLOGIST (temporary), on the staff of the Geological Survey, Department of Industry and Commerce—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (December 20).

TECHNICAL ASSISTANT IN THE ELECTRICITY DEPARTMENT—The General Manager, Electricity Offices, Ferensway, Hull (January 1).

LIBRARIAN—The Secretary, Society of Antiquaries of London, Burlington House, Piccadilly, London, W.1 (January 31).

CHAIR OF ENGINEERING—The Secretary, The University, Aberdeen (March 31).

SENIOR LABORATORY ASSISTANT IN THE DEPARTMENT OF ZOOLOGY—The Secretary, Bedford College for Women, Regent's Park, London N.W.1.

PRINCIPAL OF THE MERRIST WOOD FARM INSTITUTE, Guildford—The Chief Education Officer, County Hall, Kingston-upon-Thames, Surrey.

RESEARCH WORKER on the nature and composition of the anti-anæmic principle in liver, and a RESEARCH WORKER to prepare and employ purified or crystalline digestive ferments—The Courtauld Institute of Biochemistry, Middlesex Hospital, London, W.1.

HYDROGRAPHICAL SURVEYOR for the Basrah Port Directorate, Iraq—The Ministry of Labour and National Service, Appointments Department, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. A.4962.S).

TEACHER FOR PHYSICS AND CHEMISTRY—The Acting Principal, Technical Institute, Sheerness, Kent.

HORTICULTURAL ADVISER (man) and an ASSISTANT HORTICULTURAL ADVISER (man or woman)—The Chief Education Officer, County Hall, Kingston-upon-Thames, Surrey.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

Social Insurance. Part 2: Workmen's Compensation. Proposals for an Industrial Injury Insurance Scheme. (Cmd. 6551.) Pp. 32. (London: H.M. Stationery Office.) 3*d*. net. [289

Science in Post-Primary Education with reference to the Scientific Education in Schools of Pupils of 11–18 and its relation to their subsequent Training in Universities and Colleges. Interim Report of a Sub-Committee of the Association of Women Science Teachers. Pp. vi+22. (London: John Murray.) 1*s*. 3*d*. net. [210

Re-Educating Scotland. Edited by Naomi Mitchison, Robert Britton and George Kilgour. (Published for Scottish Convention.) Pp. 48. (Glasgow: Scoop Books, Ltd.) 1*s*. 6*d*. [210

### Other Countries

Bashford Dean Memorial Volume. Archaic Fishes. Edited by Eugene Willis Gudger. Article 7: The Breeding Habits, Reproductive Organs and External Embryonic Development of *Chlamydoselachus*, based on Notes and Drawings by Bashford Dean. By E. W. Gudger. Pp. 521–634+6 plates. Article 8: The Heterodontid Sharks; their Natural History, and the External Development of *Heterodontus japonicus*, based on Notes and Drawings by Bashford Dean. By Prof. Bertram G. Smith. Pp. 647–748+7 plates. (New York: American Museum of Natural History.) [49

Smithsonian Institution. War Background Studies, No. 20: China. By A. G. Wenley and John A. Pope. (Publication 3770.) Pp. v+85+25 plates. (Washington, D.C.: Smithsonian Institution.) [49

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CONTENTS



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# DISSEMINATION OF SCIENTIFIC INFORMATION

THE well-deserved tributes which have been paid to the achievements of British and other men of science in war-time almost inevitably tend to encourage in the public mind the belief that war stimulates scientific advance. That notion was exposed in "The Frustration of Science" (published by Allen and Unwin, 1935); but it is well to be reminded that, despite certain gains, on balance war tends to retard rather than to promote general advance. The advances occur in limited fields where the prosecution of the war effort is directly served, and although such advances may be turned to account in peace-time, the scientific effort expended is sometimes out of proportion to that which might have achieved the same result in peace-time. Moreover, fundamental research tends to be suspended entirely, or at best is pursued with inadequate means.

The positive achievements of scientific effort in war-time should not, therefore, be allowed to obscure the fact that a heavy price has been paid, that important fields have been neglected, and that development at best has been lopsided. It might be exaggeration to speak in the present war of the frustration of science; but there can be no denial that advance generally has been impeded, and a main cause of this has been the interruption of communications between scientific workers, both within and across national boundaries. The interruption of internal communications has already been the subject of some discussion in regard to the organization and development of scientific and industrial research in Great Britain. The international aspect is discussed by Dr. Joseph Needham in an article appearing on p. 657 of this issue.

It is, of course, to remedy the position which arises from the interruption of free scientific intercourse across national frontiers, with all that such intercourse means in the exchange of knowledge and ideas and the stimulation of creative thought, that there have been established in war-time such organizations as the British Central Scientific Office in Washington, the American Scientific Office in London, the scientific liaison officers of the various Dominions with the United Kingdom, the Anglo-Soviet Science Collaboration Committee and the Scientific Co-operation Office of the British Council in China, the organization and work of which Dr. Needham describes in some detail. It is no disparagement of the services of such liaison organizations to point out that some at least of their work in war-time is due to the interruption of normal channels of communication and the operation of the censorship. No such organizations, however efficient, can entirely compensate for the effects of withholding a scientific or technical paper either from publication entirely or from communication abroad.

In considering any new proposals for the organization of co-operation or the exchange of information in science, it is well to recall that the progress of science depends first and foremost upon full freedom of investigation and expression, and the first step

must be the removal of the constraints of war-time at the earliest possible moment consistent with world order and security. Organization, in fact, should be not a substitute for such intercourse, as in war-time it tends to be, but a supplement and a stimulant.

As to the need for such supplementing, there is little room for doubt. The report issued last year by the British Commonwealth Science Committee (see *Nature*, 152, 29; 1943) showed how much remains to be done to improve the collection and dissemination of information and collaboration in research within the Empire, while the necessity for extending such collaboration to the United States, the U.S.S.R., China and other countries or regions was clearly indicated by the Committee. The report recommended specifically the maintenance in London by the Governments of the English-speaking countries of permanent scientific and technical representation, and that such representatives of the Dominions and India and of the United Kingdom and the Colonies should constitute a British Commonwealth Scientific Collaboration Committee, to act with the Royal Society in the discussion of topics of common interest, to keep in touch with all agencies and organizations for the collection and dissemination of scientific information, to further schemes for co-operation in research, and to make recommendations and proposals for common action. Arrangements to secure the co-operation of similar representatives in London of the United States and of other countries outside the British Commonwealth were also recommended.

Already the Council for Scientific and Industrial Research in New Zealand, the National Research Council of Canada and the National Research Board of South Africa are prepared to support such collaboration, and Prof. A. V. Hill has expressed the hope that such co-operation will lead in due course to more general collaboration. There is thus in being a movement which promises to retain the science co-operation offices already established for war purposes, and to use for post-war purposes at least their 'post-office' functions. Much more than this is clearly contemplated by the British Commonwealth Science Committee, which in its report has boldly indicated some of the possible developments in the collection and dissemination of scientific information, such as collaboration in the production of scientific abstracts for the common use of the English-speaking world.

These tendencies, to which Dr. Needham directs attention in outlining his proposals, are reinforced by others, the importance of which has been enhanced since the appearance of the British Commonwealth Science Committee's report. If the value of the various agencies for co-operation in science set up under the stress of war in the capitals of the United Nations is becoming more generally appreciated, the importance of utilizing such machinery for peace purposes has also been generally emphasized. There is now general agreement as to the mistake which was made in 1918–19 in scrapping too easily and without examination the similar organizations established then for our war purposes. Furthermore, as Dr. Needham notes, the whole trend towards the establishment of functional bodies such as the United Nations Relief and Rehabilitation Administration and the Food and Agricultural Organization enforces the need for more effective co-operation in science across national boundaries. Unless that is established, the functional bodies can scarcely achieve full success.

Whether the structure of the new world order is essentially functional or regional, such scientific collaboration will be essential, and its value has been proved by the work of such bodies as the Middle East Supply Centre and the Anglo-American Caribbean Commission. It is also in line with the school of thought which, inspired by the achievements of the Tennessee Valley Authority, looks to the development of Europe's public utilities or such regional projects as a Danube Valley Authority. There is, moreover, all the experience of the League of Nations' technical committees to testify to the feasibility of such co-operation in matters like health, the opium traffic, communications and transit.

But there is a further reason why the organization of such co-operation is important, which is well brought out in a recent article on "Intellectual Co-operation" by Dr. Gilbert Murray in *Agenda*. Whatever form the world organization for peace tentatively outlined in the Dumbarton Oaks proposals may ultimately take, whether its basis is regional, functional or whether ultimately it develops into a federal system, there must be some community of thought, some general understanding of the unexpressed assumptions, attitudes of mind, characteristic of each national tradition and taken for granted by those who share that tradition. To discover and interpret such assumptions is the primary task and function in international intellectual co-operation, which in this way by encouraging the artistic, scientific and imaginative links between the nations, promotes continuous co-operation and has a powerful, though unseen, influence for good.

By and large, much of this intellectual co-operation must be by personal intercourse and conversation between the people concerned. On that fact rests part of the case for an international university, put forward, for example, by Prof. G. W. Keeton in "The Case for an International University" (Watts, 1941), with its twin functions of the organization of research into all those problems which arise in the achievement of a world-order and publication of the results of such investigations, and the teaching of the adult communities and of youth so as to develop an ordered nationalism, seeking to establish the place of individual national cultures within the general pattern. But such co-operation must not be limited to the university level; it should permeate all aspects of national culture if it is to provide the broad basis of goodwill for world order.

When all allowance is made for the limitations of space, the most striking impression which Gilbert Murray's survey makes is the comparative neglect of the scientific field. This statement that the agreement made in 1937 between the Committee of Intellectual Co-operation and the Council of Scientific Unions bore particularly good fruit might be disputed. In the scientific field, intellectual co-operation appears to have been largely sterile, and this conclusion is

supported by the paper which Dr. Arnold Raestad contributed to the British Association Conference on Science and the Citizen last year (see *Advancement of Science*, 2, No. 8, 289 ; 1943). At the session on the exposition of science, Dr. Raestad, to whose paper Dr. Needham refers, reviewed generally the work of the Institute of Intellectual Co-operation leading to the appointment in 1938 of a committee to consider the means of improving the organization for presenting the results and methods of science to the general public ; and then described the main objectives of an international centre for scientific information, the creation of which was recommended by that committee.

These objectives were, first, the continuous recording of the progress of science, and, secondly, the mobilization, as need and demand arose, of information on any scientific point of current interest. With a modest central secretariat and regional representatives, it was proposed to work through the appropriate academy of science or other scientific body in each country that respected freedom of scientific thought and expression. Nations which subordinated scientific research to racial or other prejudices were to be excluded. The functioning of one such national centre of information, started in Paris in 1939 by the French Government's National Centre for Scientific Research, was described by Mr. J. G. Crowther at the annual conference last year of the Association of Special Libraries and Information Bureaux, based on information supplied by M. Louis Rapkine. This centre, directed by Prof. Pierre Auger, was essentially concerned with the provision of information by the expert, while the proposed international centre for scientific information was intended, at least in part, though not exclusively as Dr. Needham seems to think, with the education of the general public. The latter is, of course, the prime purpose of the institute of scientific information suggested by Mr. Ritchie Calder at the same British Association Conference. The very successful work of the British Council in this field is apparent from its latest annual report, and such work is of vital importance to the stability of a new world order or organization for peace. Such an order must rest on a greater readiness, and even habit, to submit one's own judgment to the control of facts, and to respect in others the supreme freedom to ascertain and assess facts, as Dr. Raestad emphasized.

That is a prime reason why implementation of international co-operation in the exposition and interpretation of science is of such importance to the establishment of world peace. The experience of the International Unions and of the Committee on Intellectual Co-operation suggests that the more effective organization of scientific co-operation may have equally important results in scientific circles themselves. It at least offers the prospect of breaking down some of the insularity and rigidity to which national professional organizations are inevitably prone, of stimulating that fundamental and creative thinking about their functions for which Prof. A. M. Carr-Saunders and Mr. P. A. Wilson pleaded in their study of the professions. Scientific workers, at least collectively in their professional associations, have been singularly blind to the possibilities which technical developments such as the microfilm or air transport hold for the improvement of their own ancillary services such as abstracting and publication, and the picture Mr. Crowther gave at the Conference of the Association of Special Libraries and Information Bureaux of the work of the French National Centre was most suggestive.

This, then, is the broad background against which Dr. Needham's proposals for the establishment by the United Nations of an international science co-operation service, as a functional body parallel with the International Labour Office and the Food and Agricultural Office, have to be considered. This would presumably fit in under the Economic and Social Council of the Dumbarton Oaks proposals, and could possibly be financed on similar lines. The permanent headquarters of the service would probably be determined by the centre selected as the headquarters of the general international organization, though, apart from the central and peripheral permanent secretariat, a considerable proportion of the officials of the service should, in Dr. Needham's scheme, be working men of science, selected to ensure that the organization always preserves the true atmosphere and understanding of research.

The functions of this international science co-operation service are to be the promotion of all aspects of scientific co-operation, the collection and dissemination of scientific information, the furtherance of schemes of research collaboration, facilitation of the movement of scientific workers across national boundaries, provision of advice on scientific matters to government and diplomatic personnel of individual States when desired and the provision of scientific assistance to all international organizations. Dr. Needham gives no clear idea as to how the new organization is to be developed from existing organizations, although he indicates some which might be linked up with it at a later date. His suggestion that the service should have permanent representatives in all countries or regions might be taken to indicate that he visualizes it as developing out of the scientific offices at present maintained in London, Washington and Chungking. This further proposal that such representatives should have diplomatic or 'League official' status and guaranteed government facilities for communication and transport reflects the suggestion made by Lord Samuel in the House of Lords last year regarding the appointment of scientific attachés to the principal British embassies abroad, or that Great Britain may have liaison officers who can bring to the notice of those interested at home the progress and methods which have been achieved or established in other countries.

The question of diplomatic status is a detail that requires somewhat fuller consideration when the proposals have reached the stage of a definite scheme. It is true that, as current criticism of the Foreign Service has emphasized, the basis of recruitment of that service requires widening, that it is important it should include those qualified to recognize important scientific and technical developments abroad and

to advise authoritatively on problems of science and technology. There is, however, also the question of loyalties, and in conveying science and technology from the industrially advanced Western countries to the less advanced Eastern ones, confidence in such advisers as genuinely unbiased and disinterested may best be fostered if their first loyalty is seen to be unmistakably to science. Diplomatic facilities might be too dearly bought if they involved any compromise in that fundamental loyalty to the pursuit of science.

The proposals that Dr. Needham has advanced merit the serious attention of scientific workers. The case for some substantial improvement in what may be termed the 'communications of science', both inside its own special field and in its exposition to the public generally, is unchallengeable. That development must be a vital part in the new world organization to be established and for the success of new functional or regional institutions. Moreover, the proposals represent a challenge to existing professional associations, which, if accepted, may have invaluable consequences for the advance of science itself by the improvement of contacts, the stimulation of creative thought, the adoption of new techniques of communication and the facilitation of co-operation across and within national frontiers in the attack on the many problems the solution of which is imperative if mankind is to enjoy the bounty which science has put within our power to command. How great are those possibilities can be glimpsed from the stimulating survey of the study of land settlement to which Dr. Isaiah Bowman devoted the greater part of his presidential address, "Commanding our Wealth", to the American Association for the Advancement of Science last September (*Science*, **100**, 229; 1944). One of the roots of the tree of peace, he urged, is science; but if a true science of land settlement is to emerge, if we are to harness to the affairs of peace, as the Prime Minister said in his broadcast from Quebec last year, science, good sense and experience as well as hope, there must come first the removal of barriers of regulation or misunderstanding, tradition or prejudices hindering the free communication of information and interchange of men of science or of ideas throughout national and international life. After that will come new organizations, on the evolution of which in appropriate forms fresh, critical and unprejudiced thought and sound judgment must be brought to bear.

## A SURGEON LOOKS AT MEDICAL EDUCATION

### Rational Medicine

Comments on Social Medicine, Surgery and Education. By Basil Graves. Pp. xi+292. (London: Nicholson and Watson, Ltd., 1944.) 12*s*. 6*d*. net.

THE author of this book is an ophthalmic surgeon. His original purpose, he states, "was to describe and suggest the reform of certain anomalies that exist in present-day educational and surgical practice". As he proceeded in this enterprise, he encountered other lions in the way, in pursuit of which he has wandered down side-paths far removed from the beaten track. These digressions, in spite of a fluent style and much erudition, make the book difficult reading and involve much repetition.

In discussing the question of specialism, Mr. Graves draws chiefly on his own experience. He cites several unhappy examples of men who, despite high professional qualifications, have bungled operations on the eye. He avers, and no doubt with truth, that some surgeons are unfitted by training or experience for the specialty they profess. He rightly castigates the pseudo-specialist and the fetish of a brass plate in some particular street; and barbs the arrows of his attack with anecdotes and quotations. This criticism of his professional brethren is not vindictive. He remembers that most of them do excellent work, have a high sense of their calling and endeavour to mitigate the lot of human suffering. He holds that often incompetency results from unsuitable training, which has comprised general surgery and memory tests bearing little relation to future specialized work.

The truth of the matter is that medical examinations, qualifications and postgraduate diplomas testify to a man's reading and intellectual capacities, but to a considerable extent they also assess a candidate's clinical competence in diagnosis and treatment. The wealth of new knowledge that has enriched medicine during the past fifty years has greatly over-burdened the student of medicine with theoretical data; but all experienced examiners will agree that final and postgraduate students who fail do so chiefly in the clinical part of their examinations.

No man should presume to engage in specialism on academic qualifications alone and without a prolonged period of practical experience in hospital under the direction of recognized authorities. Only a minority have departed from this usual procedure, and those who have done so have usually regretted it. The incompetent surgeon, even if he buries his failures, gets weeded out and betakes himself to some other branch of the profession.

Mr. Graves considers that few important individual contributions to general knowledge have come from famous surgeons, though he admits Wilfred Trotter was an exception. But one could compile a long list of surgeons who have made such contributions. Sir James Paget and his son, Stephen Paget, Sir Frederick Treves, Sir D'Arcy Power, Sir Rickman Godlee, Prof. Grey Turner and many others. Sir Victor Horsley was not only a great cerebral surgeon and physiologist, but he was also a social reformer. The examinations for the fellowship of the Royal College of Surgeons of England cannot always cripple reflective thought as Prof. Tonks supposed (p. 23). Indeed, being himself a holder of that diploma, his own career as an artist refuted the statement.

The author rightly considers that there should be no social distinction between intellectual and manual work, and he extols the beauty of craftsmanship. The pity of it is that mass production and modern industrial processes are gradually eliminating the craftsman, with his appreciation of beauty and love for the work which grew under his hands. The medical profession itself is a blend of intellectual and manual labour, for the medical student from his pre-clinical days is trained how to use his hands, as is the student of science in physical, chemical and biological studies. He or she must be both thinker and craftsman.

Mr. Graves's views on the defects in the system of general education are specially endorsed by Sir John Graham Kerr in an appreciative foreword to the book. There is the waste of time devoted to rote-memorizing "with its disastrous interference with the development of originality and character, and with other things that really matter: as in the case of hospital nurses whose training in the very human and womanly art of nursing suffers from the amount of time demanded for the memorizing of masses of detail relating to anatomy and physiology; and the greatly exaggerated importance attached to written examinations as a means of testing ability". The main aim of education should be to develop the biological worth of the individual. With these arguments, which are reinforced by quotations from the educational experiences of Winston Churchill, H. E. Gorst, William James, Herbert Spencer, A. J. Balfour, Bernard Shaw and Thomas Huxley, most readers will be in agreement.

Mr. Graves also deals with a most important point. Boys and girls have to prepare for examinations at a time when they are already exposed to the strain of adolescence. This combination of physical and mental strain is most unfortunate, and occasionally leads to disastrous results. Examinations are possibly necessary evils, but because some children develop intellectually early, others late, they are imperfect tests of future mental ability. We must resist the educational 'gradgrinds' who, on the result of examination tests, would put every child into permanent intellectual pigeon-holes at the age of fourteen or sixteen years.

Mr. Graves admits he is on less firm ground when he comes to remedies for his present discontents. His suggestion, for example, for evaluation of a surgeon's operative skill—even by slit-lamp examination in ophthalmology—will scarcely prove acceptable in practice. As the author himself points out (on p. 50), the surgeon deals with living tissues the reactions of which cannot by any means always be determined or controlled, so that a case may prove disappointing even though the patient has received most competent specialized attention and the most skilful operating procurable.

Reform is, however, on the way, and in many directions. The Royal College of Surgeons is considering the practicability of instituting a special F.R.C.S. diploma in ophthalmology, which should go a long way to meeting the author's criticisms of the present examination. Furthermore, since this book was written, Sir William Goodenough's Inter-departmental Committee has reported on medical education: in its recommendations more attention is to be paid to clinical experience, less to rote-memorizing, while every candidate, it is proposed, should have a compulsory period of hospital appointments after passing the final medical examination before being admitted to the medical register.

Concerning a State medical service, Mr. Graves advocates an intermediate attitude, and his views seem likely to receive much general support from the profession.

This is a controversial treatise, and not all the writer's contentions will be acceptable. Enough has been said to indicate the book's earnest purpose and its provocative and challenging character. Its appearance is timely, for many of the questions it propounds are now being discussed by the medical profession and by all those who are interested in health and social reform.

ARTHUR S. MACNALTY.

## SCIENTIFIC METHOD IN ECONOMIC PROBLEMS

### The Future of Economic Society

A Study in Group Organisation. By Roy Glenday. Pp. viii+320. (London: Macmillan and Co., Ltd., 1944.) 16*s*. net.

THIS book claims in its first sentence to be an "attempt to apply the scientific method to the study of economic problems", and to readers of *Nature* the question of prime importance must be how far Mr. Glenday has succeeded in this difficult task.

The early biological chapters, the constant reference to statistical data, the obvious wide reading of the author create a favourable impression. Here obviously is a scientific work, in so far as 'scientific' means both taking account of the conclusions of other sciences such as the natural sciences, and beginning with the observed and measured facts of your own science, in this case the facts of human society.

It is true that the author has the habit of attacking economists somewhat indiscriminately, even those like Colin Clark who have tried to pursue the same scientific method. It is true, too, that the author arrives at conclusions even more gloomy than those of the 'dismal science' itself. He finds that the high unemployment suffered in the inter-war years is not just a passing phase, but (p. 176–7) "the accepted index that a given organization is in process of breakdown", and that "superficiality of diagnosis seems to underlie the popular theory that the problem of persisting unemployment could have been solved either by the institution of public works, the equating of savings to investment—or, if all else failed, by setting those out of work to provide for their own needs". To quote Mr. Glenday's own summary, he foretells (p. 19) that "the days of the present economic society are numbered", meaning by this a society based (p. 20) on the ideal of the intrinsic uniqueness of individual man as against that of the subordination of the individual to the community. But however disputatious the attitude or gloomy the prophecies, a scientific critic must be put off neither by the incidental fireworks of controversy nor by the unpleasantness of the findings. He must inquire into the validity or otherwise of the *basic* conceptions and methods underlying the results.

At least two serious flaws appear to me in the structure of the argument. The first is the assumption that continuous geometrical progression must be expected; and if it is not attained, but merely arithmetic additions, that there is cause for despondency. Yet, as the series 1, 3, 6, 10, 15 exemplifies, it is quite possible for a continuous fall in growth-rates also to show a continuous rise in additional increments. Occasionally, indeed, Mr. Glenday must be accused of dressing up his graphs for the funeral pyre. There is a depressing diagram (Fig. 5, p. 78) showing the decline in growth-rate of five important items in American economic life between 1840 and 1930. In four of these—railroad mileage, steel tonnage, automobile registrations and electric power—the curves plunge downward catastrophically. But what are the facts of America? A continuous addition in all these items per head of population, compared to which the falling geometrical rate of growth is frankly just an academic abstraction.

The second flaw in Mr. Glenday's argument is his piecemeal approach. He takes a number of separate industries and shows statistically that their rate of

growth is falling, and in some cases that they are arithmetically declining. But this does not allow for the fact that some industries are failing because more efficient methods of doing the same thing, or of doing better things, are taking their place. Railroad track mileage, for example, might well be declining absolutely because motor roads were substituted for purposes of transport. But there is no reason to be gloomy about it. On the whole, social progress has involved changes in consumption in the shape of substituting more intangible and variegated goods and services for easily measured staples, so that there is here a special risk that statistics, more easily obtained for the tangible output, may often be misleading for standards of consumption as a whole. In fact, attempts by economists such as Prof. A. L. Bowley, Mr. Seebohm Rowntree and Mr. Colin Clark to assess the total national real income by scientific methods of statistical computation show for Great Britain a continuous increase in goods and services per head of population during the twentieth century, with no sign of fading out.

The parts of the world where gloom may be scientifically justified are the 'have not' countries, where increasing production is simply allowing more and more population to stay alive and to keep down the *average* standard of living per head. These Malthusian conditions to-day affect countries containing at least four-fifths of the human race; but Mr. Glenday (p. 253) purposely omits them from his thesis.

Ancillary to Mr. Glenday's main thesis, many problems are discussed that arouse great interest. Notable among these are the satiation of wants (p. 204), where the author seems to under-estimate the possibilities of raising the consumption of the poor by those very social charges he deplores; and the problem of co-ordination (p. 186) arising from the distance separating the main food-producing areas from the industrial areas of the world.

Mr. Glenday writes clearly and without circumlocution. Though he does not prove his main thesis, and is handicapped in interpreting the facts by neglect of the useful apparatus of thought provided by economics, yet his book does at least tackle the essential dynamic problem of the trend of events, does start with the facts, and does present them forcibly.

P. Sargant Florence.

## SOCIAL HUMANISM

### The Humanities Look Ahead

Report of the First Annual Conference held by the Stanford School of Humanities, 'The Humanities in the War and Postwar World', May 7 and 8, 1943. Pp. ix+149. (Stanford University, Calif.: Stanford University Press; London: Oxford University Press, 1943.) 10*s*. 6*d*. net.

In many ways the conference at Leland Stanford University, at which the seventeen papers collected in this volume were read, was characteristically American. It was as ready with self-criticism as with plans for action. Now that the arts, true science and philosophy are all "dislodged and beaten almost beyond surviving there in Europe and Asia", for the first time the United States of America, in the words of Prof. Paul Green, had leadership in this field thrust upon her. They met, however, "not to save the humanities" but to find the conditions "under which they would be worth saving". It was natural to begin the quest with an attempt to find out what was wrong with them now, and the speakers agreed on two main points. The humanistic field itself had become divided between, on one side, a few small groups living complacently a life of intellectual preciosity, who had forgotten that humanism had to serve humanity, and on the other side, a frightening array of people engaged on 'exact' research who had little sense for what Croce has called 'the feeling of the living soul'.

The second general cause of that decline was the growing gap between humanism and science. Prof. Frederick Koenig attributed that to the enormous growth and specialization of science, which had left the several disciplines high and dry as isolated islands, no longer fertilized by a common stream of philosophy; a separation accentuated by difference in temperament between the practitioners. The "scientists are unable to see that artists have brains, and artists are unable to see that scientists have souls". In such conditions humanism could not inspire the individual, in Symond's definition, with a "vital perception of the dignity of man as a rational being", or achieve its wider academic function, as defined by Dr. Leland, of "bringing understanding out of knowledge". The role of the humanities in their academic precincts and functions was indeed the central theme of the discussion; and while "Social Humanism" was the title of Prof. Borgese's paper, with its passionate generalities and its call for a 'Republic of the World', the British reader will find its substance rather in the papers which described American experience and experiments. Dr. Waldo Leland, the distinguished director of the American Council of Learned Societies, put the problem acutely when he said that it was "how to make human energy intelligible to itself". (Dr. Leland incidentally announced that his Council was about to publish a report on the part of the humanities in a liberal education.)

To the general causes for their decline, Dr. Leland added a more practical one, namely, the excess of students, with the resulting dilution in the qualifications of both students and teachers. Closely allied with over-specialization was the failure to keep up an active inter-relation with the sciences and, especially, with the social sciences; and last, but perhaps most serious, the failure of many scholars to "concern themselves actively with education". That was perhaps as true of men in the sciences, but for the humanist education was the very soil he had to till. The function of the humanist was so to inspire the learner that he may "develop for himself not a career but a character", said Mr. David Stevens, of the Rockefeller Foundation, who gave a survey of the Foundation's practical work in this field during the past ten years. Prof. Waldo Dunn described an experiment in humanistic education at Scripps College; and Prof. Linden Mander that of Washington University, where by various means the University is trying in characteristically practical ways to widen the range permeated by its educational work. All that corresponded to the two conditions which the conference seemed to think necessary for reclaiming the humanities: first, some unity of philosophical outlook in the world of thought and, secondly, the permeation with it of man's world of action. Two quotations from Mr. Lewis Mumford's final paper on "The Making of Men" may serve to round off an inevitably inadequate summary of this lively conference: "Our mistake consists in thinking that there

is anything final or absolute in the present form and traditional methods of the university, and in not seeing that if only a profound change in all our cultural habits will save our civilization, we must plan and effect that change". "But here we must transcend the limitations of our own humanist tradition : for the first step toward world co-operation must rest on our realization that the humanities are not a special creation of Western civilization. . . . Unless we are humble enough to learn from all these sources", humanists will miss the opportunity of "carving out a much larger and much more significant place for themselves than they have ever occupied before". DAVID MITRANY.

## THE EXPANDING LIBRARY

**The Scholar and the Future of the Research Library**
A Problem and its Solution. By Fremont Rider. Pp. xv+236. (New York: Hadham Press, 1944.) 4 dollars.

THE growth of American research libraries, averaged together, according to figures quoted by Mr. Fremont Rider, shows a doubling at almost exactly sixteen-year intervals, and there seems no good reason for believing that the rate of growth will be seriously checked for many years to come. If unchecked, the figures for some of America's largest libraries will become astronomical. Though, for a variety of reasons, the rate of growth of British libraries is not equally rapid, there is much of value and interest to be found in Mr. Rider's examination of the problems involved and in the suggested solution.

In the first part of the book, Mr. Rider recapitulates various current methods of reducing the growth of research libraries, and shows why they cannot be wholly satisfactory. He is entirely concerned with the problem of the research library serving the more advanced type of reader; comparable, in fact, to British national libraries such as the British Museum or the Bodleian. In such libraries it is an axiom that no class of material can be discarded with impunity. Even the trivia of to-day may prove valuable in relation to sociological or biographical research a century later. The scholar's needs are casual, but they are also urgent and unpredictable. In a satisfactory service he expects, within reason, to have his material available for quick consultation.

Mr. Fremont Rider's solution lies in 'micro-cards'. By this term he means the reproduction, in micro-print, of the text of the book or paper itself, on the back of a catalogue card. The face of the card would show the catalogue entry and an abstract of the work, in print of ordinary size. A careful choice of the form of the catalogue entry would enable the same cards to be used for author, title or subject catalogues, thus doing away with the need for further copying or additions by the subscribing libraries. Mr. Rider specifically suggests the use of the 'Readex' process, by which it is possible to print 100–250 pages of a book on a standard library card, but other adaptations of micro-photography are also possible. The resulting economy in space and cost is obvious.

The second half of the book deals with the micro-cards, their format, publication and uses, and with the problems of copyright. Mr. Rider stresses the fact that success in the use of micro-cards will depend largely upon an agreed format for the catalogue entry and subject headings, since interchangeability of cards among the subscribing libraries is an absolute necessity. It is therefore of great importance that the cards should be made, in the first place, by bibliographical experts. Mr. Rider recommends an extension of the division-of-fields suggestions already put forward by the Metcalf Committee. According to these proposals, each of the co-operating libraries would select its own particular sphere of interest and would endeavour to collect all research material pertaining to this field. Mr. Rider suggests that each of the co-operating libraries, thus having at hand all data relevant to its own field, would be in the best position to draw up the most accurate catalogue entry and subject classification for such material. Each library should therefore issue the micro-cards for works within its own field, receiving in turn micro-cards from other libraries specializing in other fields.

Objections to the schemes proposed by Mr. Rider could be immediately suggested, but much remains that is worthy of close attention. Micro-print, as distinct from micro-film, is still in the early stages of evolution, and reader-machines are in short supply. It may, however, reasonably be anticipated that supply will follow demand and that improved technique and equipment will rapidly be developed.

The method of combining the legible catalogue entry with the actual text of the original eliminates many of the disadvantages of micro-film and has much to recommend it as a self-contained and rapid means of access to reference works. Those who have felt that the potential value of micro-photography as an aid to the solution of library problems has not yet been fully utilized should draw inspiration from this book. E. M. R. DITMAS.

## BRITISH PLANT DISEASES

**List of Common British Plant Diseases**
Compiled by the Plant Pathology Committee of the British Mycological Society. Pp. 61. (Cambridge: At the University Press, 1944.) 5s. net.

SO far back as 1928 the British Mycological Society decided to appoint a committee of men of science interested in plant diseases, their object being to compile a list of the more important diseases of British crop and ornamental plants and to suggest for each disease a single selected common name. It was hoped to encourage the use of these selected names so that uniformity in the naming of plant diseases could be achieved at least in the British Isles. Many people dealing with plants must be aware that the same disease of a particular plant may be known by several common names according to the locality, and furthermore that a name is often quite unsuitable for describing the disease to which it refers.

The Committee produced its first list in 1929 in the *Transactions of the British Mycological Society*, **14**, and further improved on this by publishing a second edition of the list in book form in 1935.

It has now produced in book form a third edition, with various emendations and additions, printed as before in two parallel columns, on the left the name of the host plant with, under it, the recommended common names of its diseases, and on the right the scientific name of the parasite causing the disease. In the case of diseases not caused by

fungus or bacterial parasites the right-hand column gives the name of the causative agent, for example, mosaic virus, manganese deficiency, irregular water supply, etc. There is one important change in lay-out as compared with previous lists, this being the fact that the host plants instead of being arranged in groups, such as fruits, vegetables, etc., are now all placed in alphabetical order according to their names as ordinarily used. The result is that there is no need for a host-plant index.

In the case of the more important diseases which are also prevalent abroad, foreign common names from several countries are given in slightly smaller type under the selected British common names. There are an index of authors' names and abbreviations, one of the accepted scientific names of both host plants and parasites, and one of foreign common names of various diseases. Many readers will note and approve the separate index providing common names of diseases in Russian.

This attempt at uniformity in nomenclature of diseases is to be commended in a field where confusion is still too often met with. The fact that changes repeatedly occur in the scientific names of plant disease parasites makes this list doubly important to workers in this subject, and the Committee deserves the thanks of both research and advisory plant pathologists for providing such an up-to-date book of reference. There is no doubt that it will be welcomed by all concerned with plant diseases throughout the British Empire.

D. E. Green.

## FOOD HABITS

### The Origin of Food Habits

By H. D. Renner. Pp. 261. (London: Faber and Faber, Ltd., 1944.) 15*s*. net.

ALMOST the last habits anyone will give up are his food habits. So the average man is the despair of the dietitians and the Ministry of Food, who wish him to eat what is 'good for him' or what foods are available.

In the matter of food habits there are two sharply divided schools of thought: the one which we may call the 'Marie Lloyd school', which believes that food habits are based upon instinct and that what a man fancies does him good; and the other which considers all food habits conditioned reflexes due to upbringing. Most dietitians belong to the latter school. Any digestible substance which can provide calories, proteins, mineral elements and vitamins they call a food, whether the eater likes it or not. He can, they say, acquire a conditioned reflex for that food by practice, and quote illustrations from the War of 1914–18, when children brought up to eat margarine during the War refused butter when it became available after 1918. They also bring in observations made by explorers and anthropologists such as Stefánsson[1] and Margaret Mead[2]. The 'Marie Lloyd school' retort with Pavlov's own work on the psychic flow of gastric juice evoked by pleasant foods in dogs and the extension of Pavlov's work to man by Carlson. Moreover, there is Carl Richter[3], who has brought evidence to bear that Baltimore children behave towards cod liver oil as if guided by need rather than by conditioned reflexes.

The book under review collects evidence which will be used by both schools. The writer, who is rather heavily Teutonic in his handling of the problem, puts his emphasis on experimental psychology. For example, he thinks that people who are fond of food gobble it because they do not want to fatigue the sensory organs, and that when a food "goes round and round" in the mouth it is because the eater wishes to fatigue his gustatory apparatus for the unwanted food, so that he can swallow it without nausea. Surely simpler physiological explanations will cover both cases?

Though there is much in this book which every person interested in food, whether from gastronomic or dietetic reasons, will disagree with, it is one which every such person should read. It is difficult to sum up its attributes, and perhaps the best way to describe it is to borrow what Dr. Johnson is supposed to have said of the haggis: it is fine confused feeding.

V. H. Mottram.

[1] Stefánsson, "The Friendly Arctic" (Macmillan and Co., Ltd., 1921).
[2] Mead, "The American Character" (Penguin Books, Ltd., 1944).
[3] Richter, "The Harvey Lectures" (Science Press Printing Co., 1943).

## PROF. THE SVEDBERG

### The Svedberg, 1884–1944

Pp. 732. (Uppsala: Almquist and Wiksells Boktryckeri A.-B., 1944.) n.p.

IN universities, as in other walks of life, the personal expression of gratitude and appreciation is a rare event, and the means and opportunities of expression both difficult and infrequent. This volume was compiled by colleagues, friends and pupils to celebrate the sixtieth birthday of The Svedberg. If the limitation of war had not been imposed on the compilation, contributions would certainly have come in from all parts of the world.

Svedberg's original work lay in the field of colloid chemistry; but in 1923, as a result of a visit to Wisconsin, his interests were aroused in the possibilities of an ultra-centrifuge. While it is the development of this as an instrument of precision that gained for Svedberg his international reputation as well as a Nobel prize, his interests and activities are in fact much wider. Although he is by title professor of physical chemistry, it is significant that no less than thirty-one of the fifty-six communications in this volume lie in the field of what may now be termed biophysics. Another significant trend emerges in studying this volume—one which doubtless has been accentuated by the War, but which is a real part of the activities of the Institute—namely, the part played by Svedberg and his colleagues in the national economy of Sweden by co-operation with industries to the great advantage both of science and technology.

The volume contains a brief account of the Institute of Physical Chemistry at Uppsala, together with a number of original papers from the various departments of the University. Communications from other universities and high schools, notably the University of Lund, as well as from industrial laboratories are included. The topics dealt with cover a wide field of chemistry and biology, several of them naturally dealing with supercentrifugical, optical and electrophoretic measurements of biological material.

This collection of papers may be regarded as a cross-section of Swedish activities in chemical research during the war period, and any country might well be proud of such work and of The Svedberg, whose influence in and beyond the confines of Sweden has been so profound.

Eric K. Rideal.

# AN INTERNATIONAL SCIENCE CO-OPERATION SERVICE

By DR. JOSEPH NEEDHAM, F.R.S.

ON the occasion of the recent meeting of the Royal Society in India, and the admission of several Indian fellows, Mr. Winston Churchill sent a message which included the following words: "It is the great tragedy of our time that the fruits of science should, by a monstrous perversion, have been turned on so vast a scale to evil ends. But that is no fault of science. Science has given to this generation the means of unlimited disaster or of unlimited progress. When this War is won we shall have averted disaster. There will remain the greater task of directing knowledge lastingly towards the purposes of peace and human good. In this task the scientists of the world, united by the bond of a single purpose which over-rides all bounds of race and language, can play a leading and inspiring part"[1].

When, however, we come to the concrete necessity of implementing these truths, we see everywhere a growing conviction that after the War a much higher degree of international science co-operation must be attained. There are many who believe that the time has gone by when enough can be done by men of science working as individuals, or even in groups organized in universities or societies, within individual countries, and contacting each other as individuals, across national boundaries. Science and technology are now playing, and will in the future increasingly play, so predominant a part in all human civilization, that some means whereby science can effectually transcend national boundaries is urgently necessary. The various science co-operation offices which have already been set up under the stress of war in the capitals of the United Nations constitute a piece of machinery too precious to be allowed to disappear after the War.

The fundamental need for more intimate scientific contact among the nations might conceivably be met by a system of scientific attachés at the various embassies; but this might be found to harness the free movement of science in too much diplomatic formality. It is more likely to be partly met by sending from one country to another industrial scientists with loyalties limited to particular commercial interests; but this is very unsatisfactory, for their advice is unlikely to be truly unbiased and disinterested. What many of us would like to see would be an international science co-operation service, the representatives of which in all lands would have diplomatic status (or whatever status was accorded formerly to League of Nations officials) and full governmental facilities in communication and transportation, but who would be drawn from both government and academic laboratories, and hence would be free from commercial entanglements. One of the immediate aims of such an international service would be the conveyance of the most advanced applied and pure science from the highly industrialized Western countries to the less highly industrialized Eastern ones, though this is not to say that there would be no scope for westbound traffic too. In what follows, these ideas will be more fully worked out and concrete proposals made.

## Existing Machinery

Many recent recommendations (for example, the Beveridge Report, the Unilever paper on unemployment, the Nuffield College Statement, and the Report of the League's Delegation on Economic Depressions[2]) have laid great emphasis on the desirability of utilizing whatever is possible among the international agencies established to further co-operation during the War. It is generally recognized that the similar organizations which grew up during the War of 1914–18 were scrapped much too lightheartedly in 1918.

At the present time, then, a number of offices have been established to further scientific co-operation. Working trans-Atlantically are the British Central Scientific Office in Washington, maintained by the British Ministries of Supply, Production and other British organizations; and the American Scientific Office in London, mainly connected with the Office of Scientific Research and Development. Through these two offices, an enormous amount of information, of first-class war importance, has passed. As between Great Britain and the Soviet Union, apart from the detailed co-operation of war technologists and important visits of specific missions, such as the Surgical and the Chemotherapeutical Missions, there is in London an Anglo-Soviet Science Collaboration Committee, with which Sir John Russell has been prominently associated.

In view of China's relative backwardness in the industrial and technological field, it was natural that scientific co-operation between Chungking and the other United Nations' capitals should have been rather slow in getting under way, but since the early part of 1942 a Sino-British Science Co-operation Office (British Council Scientific Office in China) has been working very actively there. Since this Office has been under my charge, and since its working, in spite of exceptionally severe difficulties, both material and linguistic, helps to indicate the kind of thing that a science co-operation office may do, a short description of it may be given.

The Sino-British Science Co-operation Office (British Council Scientific Office in China) is financed by the British Council (for cultural relations with other countries), but was also accepted into an organic relation with the Chinese Government through the Council for the Promotion of Science in the National Defence, which has the status of a sub-committee of the Executive Yuan. It has, at present, a staff of seven scientific men and women, four British, two Chinese and one Indian. Its head works closely with the British Ambassador and the Ministers of all departments of the Chinese Government concerned with science and technology. In matters of pure science he is in continuous contact with the Science Division of the British Council, and in matters of applied and war science with a China office in the British Ministry of Production.

The work of the Office is divided into three aspects, which may be called respectively contact, supply and output. Under the first, a channel is available whereby Chinese Departments, such as those of Health, Mining, Ordnance or Agriculture, can maintain contact with the corresponding organizations or any other agencies desired in London or Washington (in the latter case through the British Central Scientific Office there). Help is also made available from India, as, for example, in the printing of maps for the Chinese Geological Survey, or the provision of a list of edible and poisonous plants in North Burma and the Shan States for the Chinese Surgeon-General. All such dependence on India as the forward base for Chinese science and technology involves careful maintenance of contact.

In the field of supply the great task has been to do something towards breaking the blockade of China's scientific life after the planned destruction of her laboratories by the Japanese and their re-establishment in the non-industrial hinterland. The Office is available to supply, and has supplied in very substantial amounts: (*a*) already existing information on any question in either pure or applied science, (*b*) ideas and proposals from the West to meet specific problems arising in China, (*c*) scientific literature in all branches, including books, typescripts, offprints, microfilmed journals, microfilm reading-machines, etc., (*d*) actual essential research apparatus, instruments and chemicals. At the time of writing, some five hundred important scientific books have already reached China and some two thousand more are on the way; those from Great Britain are supplied on a kind of 'lend-lease' principle; but the Office also secures American scientific books when asked for. Nearly a hundred crates of scientific apparatus have arrived, for Government as well as university laboratories and for applied as well as for pure research.

In the field of output, the Office sends to the West (*a*) manuscript papers by Chinese men of science for publication, (*b*) current Chinese publications in science, (*c*) abstracts of Chinese work in Western languages, (*d*) articles and résumés describing the work of Chinese scientific workers and technologists, etc. The field of output is naturally smaller than that of supply, since even before an exhausting ten years of warfare China was not highly developed technically and scientifically; but even in questions of technical aid the Chinese have been not only willing but also able to help their Western Allies, as the examples of the use of bamboo in aeroplane construction, and the preparation of quartz crystals for stabilizing radio frequencies, may bear witness.

In addition to all this work, the Office is able to advise Chinese technical departments from time to time, and to give assistance to the Chinese Ministry of Education with problems of the sending of scientific personnel to the West for study.

The work of the Office has complemented in a fortunate way that of the technical experts sent to China by the Cultural Division of the American State Department. These experts, of whom some twenty-five have visited China during the past year and a half, and whose work has been in general markedly successful, have been attached to the relevant Chinese Ministries and have worked entirely, as it were, in the field. Such a system of procedure lacks a central clearing-house through which requests for scientific information and aid can be co-ordinated. The British Office, which has throughout maintained close contact with the American experts, has been able to fill this need.

It may be said that the functions of Science Co-operation Offices are largely of a 'post-office' character. There is some truth in this. The Chungking Office, in particular, has had the task of assuring contact between Chinese and Western men of science and technologists in circumstances of special difficulty, including a blockade such that communication with the outside world is only possible by air. In post-war conditions, with the resumption of normal mail communications and the disappearance of censorships, the purely post-office work of such a bureau must necessarily be expected to decrease. The post-office aspect of a Science Co-operation Bureau, however, is really only a part of its work. In order to be successful it must spontaneously collect and disseminate scientific information. Without being able to answer all scientific queries themselves, its staff must know where the answers can be obtained. They must familiarize themselves with the conditions of scientific and technical life and thought in the country where they are stationed. They must have the confidence of the resident diplomatic personnel and be able to advise them authoritatively on problems relating to science and technology. They must be unfailingly at the service of the ministers of the Government Departments concerned with science.

Even for peace-time, however, the post-office aspect of such agencies is not to be despised. In all ages, exceptional scholars have acted as clearing-houses for science and learning, and the more so the worse the political chaos of the age. In the Middle Ages the monastic houses and the Arabic translators in Spain fulfilled such functions, or the Sung Confucians in China, or, in the seventeenth century, the tireless Comenius (Bishop Komensky). Exiled from his native Bohemia, Komensky kept together through years of wanderings not only his Church, the *Unitas Fratum*, but also the band of adherents of the "new, or experimental", philosophy, whose later great achievement was the foundation of the Royal Society, suggested by Komensky himself. And when the Royal Society was founded, what a post-office did Oldenburg, its first foreign secretary, keep! He it was who opened the series of letters from the microscopist, Leeuwenhoek, in which for the first time the new world lying beyond the limits of ordinary vision was described. A scientific post-office, indeed, requires the qualities of a "department of insufficient addresses", for its aim should be to ensure that a communication reaches its proper destination, a destination that the author himself may only vaguely know.

It was said above that Science Co-operation Offices should be in a position to give unbiased advice to Governments. It was also said in the preamble that they should aid in conveying the most up-to-date science and technology from the industrially advanced Western countries to the less-advanced Eastern ones. Here is a machinery for assisting the Eastern Governments, under strictly international auspices, with genuinely unbiased and disinterested information on their problems of industrialization. It would be a substantial improvement on the scramble of advisers with relatively narrow loyalties which is otherwise only too likely to be seen.

Besides the Washington, London and Chungking offices which have already been mentioned, steps have recently been taken in London towards a much higher degree of scientific co-operation among the constituent States of the British Commonwealth than heretofore. The British Commonwealth Science Committee was set up under the chairmanship of the President of the Royal Society in October 1941 in order to secure scientific co-operation in tackling the emergency problems of the immediate post-war period, to ensure that the most should be made of common scientific resources for improving scientific knowledge and the life of the people throughout the Commonwealth, and to consider means of promoting research co-operation in pure and applied science. In an Indian article[3], Prof. A. V. Hill wrote: "The British Commonwealth Science Committee has suggested the desirability of maintaining permanent scientific and technical representation in London and possibly *also in other capital cities of the English-speak-*

*ing world*. It is further of the opinion that if scientific and technical representatives of the Dominions and India are permanently established in London, these, together with official representatives of science in the United Kingdom and the Colonies, should be constituted into a British Commonwealth Science Collaboration Committee, to act with the Royal Society in the discussion of topics of common interest, to keep in touch with all agencies for the collection and dissemination of scientific information, to further schemes for co-operation in research and to make such recommendations and proposals for common action as seem fit"[3]. Prof. Hill went on to express the hope that such co-operation would lead in due course to a more general collaboration.

The interim committee's report has been published[4]. Its discussions so far seem to have centred mostly on the extension and rationalization of the existing means of broadcasting scientific information (for example, the abstracts journals), on research collaboration schemes, and on schemes for facilitating readier movement of scientific men from one country to another. But the extension of such schemes to the United States has been discussed. The interim committee has stressed that the implications of the Atlantic Charter point inevitably to the need for closer political, social and technical collaboration with the United States, the U.S.S.R., China and other countries or regions, such as Africa. It has accordingly expressed its hope that arrangements will be made to seek the co-operation, so far as may be practicable and appropriate, of scientific and technical representatives of *the United States, the Soviet Union, China and other countries outside the British Commonwealth*, permanently established in London. The editorial in *Nature* goes on to say that "the wisdom of this last recommendation is so patent that the support of all scientific workers is assured", but urges that concrete support should be manifested by scientific men through their professional organizations. This has no doubt since been done.

The foregoing remarks will have sufficed to show that the nucleus of a British Commonwealth Science Co-operation Service has been forming in London for some time past. Since it would lack, by itself, the vigour and influence of a truly international organization, its sponsors are clearly willing and anxious to enter such an organization if it can be brought into being.

At this point the question arises as to what would be the relationship of an International Science Co-operation Service to the activities of the scientific divisions of such organizations as the British Council and the Cultural Division of the American State Department. There certainly need be no conflict. Such organizations exist to demonstrate the cultural goodwill of their respective States towards the countries receiving the scholars and experts they send, and to bring to the notice of these other countries the scientific achievements of their past, in which they take a legitimate pride. The International Service would only have to keep in close contact with all such activities.

## Existing International Bodies

For the success of an International Science Co-operation Service, it would be essential that it should come under the aegis of whatever instrument of world organization the United Nations agree to set up at the end of the War. No doubt this will be centred on the 'big four' among the Allied Powers.

The International Science Co-operation Service could thus take its place among a number of international organizations, some with broad frames of reference, others with more restricted ones, which exist already or are in process of formation. The International Health Organization and the International Labour Office, two of the most successful agencies of the League, have never died, and are now in process of re-organization. The status of the International Institute of Intellectual Co-operation seems at present indeterminate. The International Institute of Agriculture, the World Power Conference, and the International Locust Control Commission, would all, it is believed, need little or no reviving.

Among the new organizations, the United Nations Relief and Rehabilitation Administration is at present most in the public eye; but the Food Conference at Hot Springs[5] ordered the creation of an Interim Commission on Food and Agriculture which is now drawing up plans for a permanent Commission for submission to the United Nations. All such organizations must be expected to have a good deal of concern with scientific research as applied to nutrition, agronomy, etc. The International Science Co-operation Service would have to keep in close touch with that side of their activities, and since its scientific frame of reference would be broader, would probably be able to offer them considerable help. It would be expected to outlast some of them, however, such as U.N.R.R.A., the existence of which has always been regarded as probably limited.

## Current Trends

To-day one has only to open any book or paper dealing with world affairs in any relation to science and technology to find writers expressing views closely related to those here put forward. Thus Prof. D. Mitrany, in a paper recently issued by the Royal Institute of International Affairs[6], argues for what he calls the 'functional' development of international organization. International government should be organized along the line of services to meet specific ends and needs. "A different complexion would be put on the problem of security if frontier lines became overlaid with a natural growth of common activities and common administrative agencies. Moreover, functional organization offers some prospect of mitigating the difficulties which arise out of State claims to equality by evolving arrangements which show a measurable and acceptable relation between authority and responsibility, relating authority not to sheer power but to the weight of responsibility carried by the several members." Precedents here are the European Danube Commission, the North Atlantic International Ice Patrol, the North Sea International Fisheries Board and the International Astronomical Union, so important for navigation. New organizations which should on no account be scrapped are the Combined Production and Resources Board, the Combined Raw Materials Board and perhaps the Allied Supplies Executive Secretariat. An International Science Co-operation Service has not yet originated; but no field could be more suitable than science for such a type of organization.

Allied to such conceptions is that of Dr. Arnold Raestad's International Centre of Scientific Information[7]. This proposal, however, relates rather to the

extremely important subject of popular education in science. Such a centre would be continually receiving and digesting reports of scientific progress throughout the world, and producing data suitable for elaboration by the journalist, the radio speaker, the film producer and the organizer of exhibitions. It would be a projection on a world scale of agencies such as the successful American Science News Service. It might ultimately be very suitably associated with the International Science Co-operation Service.

Allied also is the proposal of the British Association's Committee on Post-War University Education that some kind of world council of universities should be set up, sponsored perhaps by the Association of Professors and Lecturers of Allied Countries in Great Britain, and the Conference of Allied Ministers of Education[8].

In quite another sphere, the changing face of the modern world has necessitated proposals for the reform of the British Foreign Service[9]. Attachés and counsellors trained in economics are expected to play a greater part in embassies after the War than hitherto. The question has often been raised whether men with a scientific training should not also be included on embassy staffs. It was debated in Parliament in July 1943[10] and the proposal strongly recommended by Lord Samuel. In the course of the discussion great emphasis was laid on the Government's post-war plan for science, including arrangements for consultation and co-operation with the Dominions and the other United Nations.

Lastly, with regard specifically to West and East, Sir Henry Dale, in his message to the President of the Indian Science Congress Association[11], said: "There is a general desire among men of science in Britain for more intimate collaboration with those in India who are working for the advancement of knowledge in the same fields of research". Similarly, Minister Chu Chia-Hua, president of Academia Sinica, thanking the foreign secretary of the Royal Society, Sir Henry Tizard, for the gift of a facsimile of the Charter Book, wrote: "We believe it is our task to help to evolve and carry into practice some guiding principles of rational education for the world as a whole. Our first step in that direction must be to encourage and start widespread intellectual cross-fertilization. The Sino-British Science Co-operation Office has already done much in that direction in this country, and we hope that it may form part one day, in the not too far distant future, of an Office of World Science Co-operation. Compared with the Royal Society, the Academia Sinica is young, and not only in age; but as an organization of intellectual pursuit, we pledge to contribute our 'widow's mite' to the general wealth and strength that will some day bring about the supremacy of the intellect and reason". This interest on the part of the Chinese in the establishment of international organization appears again in the summary of proposals issued by the Commission for the Study of Post-war World Peace, of the Chinese People's Foreign Relations Association[12]. The summary stresses the importance of "international cultural and social co-operation". It is suggested that a cultural co-operation committee be established to undertake the work of changing the mentality of the people of the aggressor nations, and of strengthening cultural contacts. As regards social co-operation, the International Labour Office should extend its activities, including the improvement of social welfare and public health administration.

## Proposals

For the purpose of discussion, the following concrete proposals emerge from the arguments of this memorandum. It is proposed:

(1) That an International Science Co-operation Service should be set up by the United Nations at the conclusion of the War under the aegis of whatever supreme international organization is devised, parallel with the International Labour Office, the International (Permanent) Commission on Food and Agriculture, and other similar bodies.

(2) That the functions of the International Science Co-operation Service should be (*a*) the promotion of scientific co-operation in all its aspects, (*b*) the collection and dissemination of scientific information, (*c*) the furtherance of schemes of collaboration in research, (*d*) the facilitation of the movement of scientific men across national boundaries, (*e*) the provision of advice on scientific matters to government and diplomatic personnel of individual States when desired, (*f*) the provision of scientific assistance to all other international organizations.

(3) That the International Science Co-operation Service be supported by funds, which relatively to those required for other purposes would, of course, be small, subscribed by the Governments of the United Nations on some agreed income-tax basis.

(4) That the International Science Co-operation Service should have permanent representatives in all countries or regions, with diplomatic or 'League-official' status, and guaranteed Governmental facilities for communication and transportation.

(5) That the International Science Co-operation Service should have permanent headquarters in some centre to be later decided on; but that apart from a central and peripheral permanent secretariat, a considerable proportion of the total number of its officials should be working scientists of every nationality serving on a temporary leave-of-absence basis, that is, seconded from governmental, academic and possibly industrial, laboratories; in order to ensure that the organization shall always preserve the true atmosphere and understanding of research.


[1] *Nature*, **153**, 63 (1944).
[2] *Nature*, **152**, 365 (1943).
[3] *Indian Information* (May 1, 1944).
[4] *Nature*, **152**, 29 (1943).
[5] *Nature*, **152**, 67 (1943).
[6] *Nature*, **152**, 309 (1943).
[7] *Advancement of Science* (British Association), **2**, No. 8, 290 (1943).
[8] *The Times* (April 3, 1944).
[9] *Indian Statesman* (February 1, 1943). *Nature*, **153**, 91 (1944).
[10] *Nature*, **152**, 129 (1943).
[11] *Nature*, **153**, 63 (1943).
[12] *Chungking Daily News* (July 5, 1944).


# WATER SUPPLY AND HEALTH

IN his Chadwick Lecture, delivered on October 3, on the "Treatment of Water in Peace and War", Lord Amulree gave a history of water supply, discussed its effect on the health of the community and described the various processes of purification which are applied to a water supply in order to render it epidemiologically safe and acceptable to the consumer, and the special precautions that have been taken during the War to protect it against war hazards.

Lord Amulree began by pointing out that water is one of the necessities of life, and stressed the

importance of ensuring its freedom from harmful impurities.

So long ago as 1832, during a cholera epidemic in Glasgow, the idea arose that the infection might have been carried by water. In this case Gorbals Parish furnished comparatively few cases of cholera, whereas in the rest of the city the epidemic was very severe. As Gorbals was provided with a soft water and the rest of Glasgow with a very hard one, the suggestion was made that the comparative freedom from cases in the Gorbals area was due to the soft water. Although this was by no means a full explanation, it was an important step forward in the epidemiology of cholera.

Next came the remarkable work of Dr. John Snow in connexion with epidemics of cholera in London in 1853 and 1854. At that time London was supplied by seven companies with water taken from the Thames and Lee and in many cases not filtered. One area was supplied by two companies, the Southwark and Vauxhall Water Company and the Lambeth Water Company, and by painstaking investigation Snow showed that whereas in the houses supplied by the Southwark and Vauxhall Water Company there were 286 deaths from cholera between July 8 and August 5, in those supplied by the Lambeth Water Company there were only 14 deaths. The former company derived its water from the Thames at Battersea, where contamination from London sewage was very heavy, whereas the Lambeth Company had, the previous year, moved its intake up to Ditton, which was free from such contamination. This convinced Snow that there was some connexion between the relative purity of the Lambeth Water Company's water and the low mortality from cholera of its consumers; but it was not until the following year, when another outbreak of cholera occurred in the neighbourhood of Broad Street, Golden Square, that he was able to provide definite proof that cholera was a water-borne disease. He found that nearly all the cases had drunk water from a pump in Broad Street, and at the end of the first week he persuaded the authorities to remove the handle of the pump so that it could not be used. As this was followed by a remarkable decrease in the number of cases of cholera, his proof was complete.

The observations of Snow have been amply confirmed since the discovery that bacteria were the causes of many diseases including cholera; but the interest lies in the fact that he reached the right conclusion by observation and deduction without any laboratory aid.

Typhoid fever is another of the great water-borne diseases. Prior to 1871, it was not differentiated in the Registrar General's returns from other diseases such as typhus and fevers of unknown origin, so that a true comparison cannot be made with what occurred in the first part of the nineteenth century; but these returns show a steady decline in the death-rate from typhoid fever from the five-year period 1871–75, when it was 374 per million living, to 4 in the last recorded period in 1936–40. "This," said Lord Amulree, "is a very remarkable and gratifying fall and must to a very large extent be attributed to a consciousness of the importance of water supplies to the public health of the country."

From what has been said, it is obvious that the most satisfactory kind of water supply is one that does not require any treatment and is drawn from an unpolluted source. Unfortunately, in a small and overcrowded island like Great Britain, it is difficult to find sufficient uncontaminated sources to supply the whole country, and many sources which in the past may have been quite wholesome have, by changing conditions, become liable to pollution.

Lord Amulree gave a warning that too much reliance should not be placed on bacteriological examination of the water, but that results obtained should be checked and used as a guide in investigating the possible sources of pollution. A word of warning was also given about the meaning of an unsatisfactory bacteriological analysis. Such a report does not necessarily mean that the whole of the consumers are immediately to be plunged into a large and serious epidemic. The presence of *Bact. coli* in the water means that the supply is liable to pollution, and that it is therefore possible that dangerous pathogenic organisms may at any moment gain access to the supply. Immediate steps should be taken to discover and remove or exclude the source of pollution, and at the same time special forms of treatment such as chlorination should be applied.

Unfortunately, a large number of water supplies in Great Britain come from rivers or other surface supplies. Rivers and streams are quite properly used in many places for the discharge of sewage effluents, and it must be remembered that no sewage treatment is aimed at making the effluent sterile, or even approaching a sterile condition, and for this reason treatment becomes necessary before the water is safe to be given to the consumers.

Proper treatment for water is complex and difficult, and requires supervision by expert staff who have laboratory facilities at their disposal. There are three stages of purification: storage, filtration and sterilization. In the early part of the twentieth century, Sir Alexander Houston, director of water examination at the Metropolitan Water Board, showed that polluted water is capable, to a very large degree, of purifying itself, if it be stored for long enough. Filtration may be done by slow or rapid sand filters. Sand filters act in two ways, by physical straining and by the biological destruction of the bacteria in the water by the saprophytic organisms in the 'skin' of the filter bed. Slow sand filters are worked at a rate of one to three million gallons per acre per day. Rapid filters work at much higher rates, and it is usual to add some chemical coagulant such as alumina to the water before filtration. Sterilization consists of adding chlorine or some other bactericide such as ozone to the water. Chlorine was first used as a sterilizer for a piped supply at Maidstone in 1897, following a serious outbreak of typhoid fever. It was extensively used by the armies in the field during the War of 1914–18 and has been widely employed since then, both in Great Britain and America, for treating water.

Like all measures which in modern times are hailed as panaceas, the treatment of water by chlorination has very definite limits. There is, for example, the danger of imparting an unpleasant taste to the water by an excess of chlorine, and there is also the fact that chlorine is only fully effective when applied to water which is free from any appreciable quantity of suspended organic matter. The adjustment of the dose to the varying condition of the water requires skilled supervision and laboratory control; it is a significant fact that of the water-borne outbreaks of typhoid fever which have occurred in recent years, most have taken place in areas where the water supply was supposed to have been treated with

chlorine. During the War, instructions were given to all water undertakings in Great Britain to chlorinate the water under their care. Lord Amulree said that this was done as a protection against sabotage by enemy agents, and has led to the erroneous idea that so long as a certain amount of chlorine is put into the water, the water is automatically safe for consumption and that very little or no care need be paid to other forms of treatment or to care of the source. This easy and fatal attitude of mind is one which it is going to be very difficult to eradicate. The fact that chlorination should be under skilled and intelligent supervision, with laboratory control, makes the process difficult to provide for in small rural supplies; hence it becomes more and more important for them to acquire a source free from pollution and to take steps to keep it so.

Some waters are corrosive to lead, and require treatment to protect the consumers from lead poisoning. This is due to the acidity of the water, and is usually corrected by the addition of lime.

Much discussion has taken place during the last hundred years on the relative merits of hard and soft water, and it has been contended that the use of a soft water not only results in a saving of soap but also that food cooked in soft water is more wholesome and more palatable, and that there is a saving in the wear and tear of garments washed in soft water. There are two processes used for water softening. One is based on the process evolved by Prof. Clark, and consists of adding lime to the water and precipitating the calcium bicarbonate as calcium carbonate. The other is called the base-exchange or zeolite method. When hard water is passed through a bed of natural zeolite or artificial base-exchange material, the sodium ions of the zeolite pass into the water and are replaced by the calcium and magnesium ions of the water which combine with the zeolite. By this means a completely softened water is obtained, and when the water issuing from the apparatus is no longer soft the material is regenerated by passing sodium chloride through it and thus reversing the exchange. In particular cases treatment has to be given for the removal of iron, which imparts an unpleasant taste to the water and stains clothing in the laundry. The treatment consists of aeration and sedimentation or filtration. Algæ which interfere with filtration and sometimes give rise to obnoxious tastes in the water may be controlled by treatment with copper sulphate or by coagulation.

Lord Amulree pointed out that the War has brought many new difficulties to water undertakings. In the first place, there was the establishment of camps and training grounds for troops, which led to the possibility of contamination of gathering grounds as well as the necessity for providing largely increased supplies of water. A further danger was the possibility of sabotage or the dropping of chemical or bacterial poisons into reservoirs from enemy aircraft. So far as is known, no attempt to poison water supplies has been made by the enemy.

The bombing of towns brought another danger, when water mains were broken in the same street as sewers. Owing to the great care that has been taken to isolate all sections of damaged mains and to sterilize them with chlorine after they have been repaired and before being put back to service, this danger has been successfully overcome.

DENISON B. BYLES.

# PROSPECTS OF CIVIL AVIATION

ON November 4 the Royal Aeronautical Society held at the Institution of Mechanical Engineers a discussion on civil aviation, and I agreed to preside. The time was appropriate in that a British Empire technical conference on the subject had just been held at Ottawa and one was going on on international aviation at Chicago. True, there is this difference in that, whereas agreement was required at the conferences, disagreement was required at the Royal Aeronautical Society's meeting in order to get real discussion.

The conduct of a meeting of this kind is always difficult: technicians are retiring, shy people as a rule, with the result that if you wait for someone to get up, it looks as if the meeting is slow, while if you call on people it appears to be pre-arranged and not spontaneous.

The canvas is very large that contains the picture of civil aviation, and it was certainly not our province to discuss any portion of it that brought in political prejudices or differences. How training or the economics of civil air transport comes within the ambit of a purely scientific society is not very clear, except on the basis that there is no one else to deal with it. I do not know whether a Saturday is a good day for such a gathering, starting at 10.30 a.m. and continuing until 6 p.m., but such was the demand to attend that tickets for admission were hard to come by and the place was full.

Brigadier-General Critchley, the director-general of British Overseas Airways Corporation, opened the discussion, speaking on training for civil purposes. He showed that much thought has been given to the subject. A pilot's career starts at twenty, for example; he must go anywhere until he is thirty-five, after which he can choose his route by virtue of his domestic ties until he is forty-five, when he comes off flying; but meanwhile he is to have training in administrative work, to see if he would be suitable for further employment in that line. It was interesting to note that one aircraft should average 3,000 hours a year and requires three crews to fly it. Accidents have been shown throughout the world to be at least 85 per cent pilot's errors.

Training for the R.A.F. and civil flying were said to be very different, a point disputed by Air Marshal Longmore as to engineers aboard. Altogether, chosen instrument or not, the personnel training of British Overseas Airways looked good, and General Critchley certainly impressed the meeting.

Major Thornton, a shipping director of Holts, an amateur flyer, a member of the Air Registration Board and a most treasured member of my Committee on Civil Aviation, dealt with the economics of flying, and startled everyone by saying he was surprised at being asked to speak on such a theme as the two subjects had never met! Coming from one who has dealt all his life with the running of tramp ships, his was a most enjoyable and instructive talk. He discussed frequency versus big machines, and showed a preference for frequency; but no one pointed out that the tiresome route London–New York non-stop compels at present a big machine on technical grounds. Major Thornton poured scorn, very rightly, on the aeroplane as a rival to ordinary freight carriers, but said it would create a new type of freight which is only of value if carried from place to place quickly.

Dr. Roxbee Cox pleaded for non-commercial routes

to be run to open up areas, an important side of this subject.

Sir Frederick Handley Page wanted to know if the jet would jump us from the speed of 200 m.p.h. to 300 m.p.h. without much difference in economy.

Mr. Peter Masefield made the curious point that 100 per cent load factor is uneconomical in view of the waste of money consumed in the organization necessary to reserve places, allot priorities, etc.; 60 per cent load factor, arrive and take your seat, would seem better! This particular subject is very large and requires and deserves much more attention than it got during a morning's discussion.

In the afternoon, Mr. Roy Chadwick, chief designer to A. V. Roe's of Manchester, who was responsible for the most remarkable of all bombers—the Lancaster—started the proceedings, but with war-time caution would only talk of conventional aircraft, whereas everyone, I believe, wanted to be done with them and dream of the next step. Along the lines of the conventional, however, he wanted a general purpose machine of about 100,000–150,000 lb. weight, 1,000 miles range, carrying thirty people, to cruise if needed at 300 m.p.h.

The great Hives followed him, the soul of Rolls Royce, and what a lot we owe to him for his own genius and the teams under him, unequalled in the world. He started by making the interesting point that whereas a locomotive does 100,000 miles between overhauls, an aero engine, although universally cursed, does 150,000 miles between overhauls. He would not admit that design for war engines is different from that of engines for civil use, except in minor points. He stressed the importance for maintenance of the whole power plant being interchangeable. Petter did not like this, but I do not think Hives meant that all power plants should be the same, as that would restrict design; but that in many machines you should be able to take out and replace the whole plant. Air Commodore Banks agreed that peace and war engines were similar.

Here I must state candidly that although both Chadwick's and Hives' contributions were most valuable and interesting, the fact that we are at war and unable for security reasons to speak of so much that is interesting, made the whole discussion rather flat; but that was not their fault.

Mr. Ogston pointed out that the cost of fuel for a year equalled the cost of the aeroplane. Hives countered with the *Queen Mary*, and worked it out in his head at more than half the cost a year!

Mr. C. G. Grey, comparing the difference in form of the Fortress and Liberator, which have identical performances, drew the startling deduction that both must be wrong and that aeronautics was not a science at all!

Mr. F. F. Crocombe put the size of a tail-less machine at 260,000 lb. before showing advantage over the conventional type. Wings, I suppose, get deep enough then to carry useful load and human beings. No trouble in landing gear in big machines was anticipated, the flexing of large spars not being mentioned.

Dr. Roxbee Cox described the jet engine well and pleaded for speed so as to get his engines to give more real horse-power. He was surprisingly optimistic on fuel consumption relative to ground covered, and I hope he is right.

Hives, in replying, admitted that Rolls Royce are in the jet business. He did not say whole-heartedly, but if this was not known before, some engine manufacturers will feel a cold douche down their backs.

Mr. W. P. Hildred, director general of civil aviation and another member of my Committee, spoke well and with great knowledge on route facilities. He put some difficult questions to us, such as what regularity of service is wanted; is ground organization spoiling pilots, what radio aids are really needed, etc., and even asked if aircraft should be self-navigating. It was noble of him to come along, bombarded and harassed as he was by the representatives at the conference in Chicago, asking for loads of information from his broad shoulders.

After tea—for the meeting went on until 6 p.m.—Mr. J. P. Jeffcock made the point that aircraft operators should compel the radio world to give them what they want rather than to take ready-made goods. After the War, radio aids should be on the ground, not all in the aircraft as war demands.

Sir Roy Fedden, president of the Royal Aeronautical Society, to whom the Society owes so much, was the last speaker, and told us what we had all realized, namely, that in spite of the hours spent, we had only touched the surface of many problems; and that once the conferences in the United States are finished, we are to have another day of discussion. The Society's secretary, Captain Pritchard, was expected to gasp, but in fact he suggested it, so in the New Year we shall be at it again.

BRABAZON OF TARA.

# NEWS and VIEWS

## Teaching and Research in Industrial Health

THE announcement by the Nuffield Trust of grants totalling £150,000 for teaching and research in industrial health is a reminder of the importance of this hitherto neglected aspect of the nation's well-being. In the early eighteenth century, Ramazzini, in his famous "Diseases of Tradesmen", emphasized the risks to health associated with certain occupations; yet it was not until the War of 1914–18 that official interest, apart from a few industrial hazards, was aroused in industrial health. In 1915 it was realized in Britain that munition workers suffering from ill-health were a serious liability to the safety of the country, since their absence affected production. The Health of Munition Workers' Committee, formed in 1915, found that few organizations kept health records, and that the need for preserving the health of those who work with hands or brain was but feebly recognized. Since 1918 progress has been made, and the recognition of the need for industrial medical officers, industrial nurses, welfare workers and labour managers has become more widely spread. It is, however, chiefly the firms with the best conditions who do the most to safeguard the health of their employees in all ways. There are numerous organizations still existing where health is nobody's concern. There are two aspects to be considered: (*a*) the need for systematic research into the actual incidence of sickness absence from various causes; (*b*) the means of expressing the results of this research in such a way that it can be applied easily. Before

the outbreak of the present War, much research had been done by the Industrial Health Research Board, but the results were only partially utilized.

Research in industrial health is not merely making an inquiry after something untoward has happened; yet this conception of research is found at times even in government departments. Research calls for much time and patient work, and should be done by people trained in its techniques. Then its initial application should be taken as seriously as the initial research: the attitude of mind of the research worker who prides himself on indifference to the application is out of place in these health problems. Finally, the results should be expressed not only for the research worker but also in a form that can be understood by people who are not specialists. In 1939, the lamentable lack of knowledge on the subject of industrial health had the same results as in 1914, though with less excuse. Medical men had little if any knowledge of the industrial conditions they were expected to understand. This should not be attributed to them as a fault, but as throwing into relief a defect in their training. We know that the total working environment, the social environment and the personalities of the people in authority, quite apart from home conditions, all play a part in determining the sickness absence of workers. It is therefore a definite move in the right direction that the trustees of the Nuffield Foundation have offered the Universities of Durham, Glasgow and Manchester, centres of large industrial populations, the financial means for the furtherance of teaching and research. It is also noteworthy that co-operation is suggested between the new departments and other departments such as science and engineering, the relevant Ministries and trades union officials, and the Industrial Health Research Board. Nor should research be limited to those technically called workers, that is, workers at the bench, but should include all those engaged in work of any kind. The grants, which are to be spread over a period of ten years, have been allocated as follows: £70,000 to the University of Manchester for a chair of industrial health; and £40,000 each to the Universities of Durham and Glasgow, at the former for the establishment of a new department under a university reader, and at the latter for a Sub-Department of Industrial Health in the present Department of Social Medicine.

## Joint Council of Professional Scientists

THE Joint Council of Professional Scientists was established for the period of the national emergency, to voice the collective opinion of qualified men of science. It was originally a joint committee of representatives of the Royal Institute of Chemistry and of the Institute of Physics, which was set up for the purpose of fostering co-ordinated action in matters of common interest, and was developed by the co-option of a botanist, a geologist, a mathematician and a zoologist, there being no corresponding professional bodies to represent those branches of science. One of the representatives of the Royal Institute of Chemistry is a metallurgist of similar standing. The Council has now been working for two years. Among matters which have received, or are receiving, its attention are the proposal to urge the Government to establish a central scientific and technical board; the Ministry of Labour's announcement regarding the minimum number of hours to be worked in laboratories and factories; the influence, on professional standards, of war-time university regulations governing the award of degrees; the conditions of service of professional men of science in the Colonial service; and the national policy regarding research and development work.

In June 1943 the Council was responsible for the issue of a statement on "The Place of Scientists in the Community". The views expressed were generally supported and given wide publicity, in the lay and technical Press, not only in Great Britain but also abroad. The Council has specially concerned itself with the resettlement of professionally qualified men of science after the War and with the various proposals which have been put forward for the proper utilization of their services. At the invitation of the Ministry of Labour and National Service, representatives of the Council gave evidence before the Ministry's Committees on "Higher Appointments" and on "The Further Education and Training of Demobilized Persons". Through the Joint Council, also, the Royal Institute of Chemistry and the Institute of Physics offered their continued co-operation with the Ministry in the resettlement period. The Council is also prepared to assist in the general resettlement of all who earn their living through their knowledge of any branch of natural science. Whether the Joint Council will continue in being when the national emergency no longer exists must depend on prevailing circumstances, and how far there may still be a need for professionally qualified men of science as such to voice their collective opinion on matters which concern the community in general, but especially themselves.

## Fuel and Power Advisory Council

A Fuel and Power Advisory Council has been constituted as follows: Sir Ernest Simon (*chairman*), Mr. Geoffrey Crowther, Sir John Greenly, Dr. E. S. Grumell, Sir Harold Hartley, Prof. C. N. Hinshelwood, Prof. John Jewkes, Viscount Ridley, Sir Robert Robinson, Mr. Geoffrey Summers and Mr. R. N. Quirk (*secretary*). The terms of reference are: "To consider and advise upon questions, referred from time to time by the Minister to the Council, concerning the development and utilization of the fuel and power resources of the country in the national interest."

## Higher Technical Education in Great Britain

IN a paper on "The Status of Higher Technical Education" published by the Association of Technical Institutions (Hon. Secretary, Loughborough College, Leics. 6*d*.), Dr. T. J. Drakeley, principal of the Northern Polytechnic, London, states that while on the Continent, "technical university studies are accorded the same status as university studies and both lead to the award of degrees, here, most of our best students, in fact most students have been discouraged from taking higher technical courses because of their apparent inferior nature"; consequently industry has received few trained men and has suffered the decline foretold by Lyon Playfair in 1852. Dr. Drakeley strenuously combats the foreign view (which is supported even by some British chemists) that "we do not possess the right temperament to maintain industrial progress", and claims that our ineffectiveness in the industrial field is due to our lack of appreciation of "the vast importance of technical training in the development of an industry—whereas we state that trade cannot be taught *within* a school, our foreign competitors realise that trade cannot be taught *without* a school".

In discussing the relation between the universities and technical colleges of Great Britain, Dr. Drakeley directs attention to the fact that some of our major technological studies are not recognized for the award of degrees, and he suggests four ways in which the British problems of higher technological education might be solved, namely: (1) by transferring all existing technological studies to the universities and inaugurating new degree courses; (2) by conferring university rank on the major technical colleges; (3) by creating a national technological university with existing major technical colleges as the core; and (4) by establishing a non-university institution awarding the equivalent of a degree (for example, a diploma in technology) in approved technical colleges. He appears to favour the fourth of these alternatives owing to the time factor involved; "we must raise the status of technical education to that of university education . . . immediately, not only for the students coming forward now to study a technology but for the men on return from the Services". Readers of *Nature* will recall that the problem was discussed in some detail in these columns towards the end of last year and again in *Nature* of June 3, 1944, p. 663.

## Skiagram

MR. W. McADAM ECCLES, consulting surgeon to St. Bartholomew's Hospital, London, has prepared a statement urging that an international effort should be made to agree on a standard term to be used for the photogram produced by X-rays. He quotes no less than nineteen words which have been used in connexion with "a negative produced upon a film sensitive to the action of X-rays". Chronologically they are:

1. X-ray.
2. X-rays.
3. X-ray picture.
4. X-ray photograph.
5. X-ray plate.
6. X-ray film.
7. Röntgen photograph.
8. Roentgenogram.
9. Actinograph.
10. Actinogram.
11. Radiograph.
12. Radiogram.
13. Sciagraph.
14. Sciagram.
15. Shadowgraph.
16. Shadowgram.
17. Skiogram.
18. Skiagraph.
19. Skiagram.

Mr. Eccles believes that two only of this collection of terms will bear scrutiny: they are 'skiagram' and 'X-ray film'. The latter is dismissed as being cumbersome and because one of the words used has alternative meanings. On the other hand, skiagram is etymologically sound (from the Greek 'skia' a shadow, and 'gramma' writing). It implies a 'shadow writing', which is a negative produced by X-rays. For some time it has been used in the scientific meaning, and it has never been used for any other purpose. Mr. Eccles therefore urges that the word 'skiagram' should be officially adopted as the standard term, so that it would be generally used in text-books, courts-of-law, medical reports, etc.

This is, of course, not the first time that reference has been made to the slipshod use of scientific terms generally and to the anomalies arising from the word 'radiogram' (see *Nature*, February 19, p. 218). The fundamental difficulty is that no body exists in Great Britain which is acknowledged as the authority on the use of scientific, or indeed other, words. Perhaps, indeed, it is foreign to the fluid character of the English language to accept direction in this manner. In the case of the word 'skiagram', however, with its relatively narrow field of use, it might well be considered by, say, the Physical Society, the British Institute of Radiology and the appropriate section of the Royal Society of Medicine, whether agreement might not be reached on the adequacy and appropriateness of the term, with the view of using it in these Societies' publications. Should it be adopted, no doubt its general acceptance would quickly follow.

## Mechanical Properties of Matter

Two recent papers (*Proc. I. Mech. E.*, 151, No. 2; 1944) deal with the properties of materials, and are of particular interest. "A Renaissance of Mechanical Properties", by Sq.-Leader A. C. Vivian, is a plea for clarity in the terms describing the mechanical properties of metals, and demonstrates the fallacy of calculating stresses on a nominal basis instead of actual cross-sectional areas. The fundamental relationship between the factors stress, strain, temperature and loading-rate is discussed in detail, and a system of symbols is suggested for defining exactly the various properties of metals. "The Significance of Tensile and other Mechanical Test Properties of Metals", by Dr. H. O. Neill, is a critical consideration of the conventional quantities obtained from the tensile test, dealing particularly with the measurement of work-hardening capacity and plasticity. Attention is given to the various methods of plotting the results of tensile tests which enable these properties to be evaluated, and numerical data are given. The discussions on both these papers are included.

## Earthquakes during July

DURING July 1944, twenty-seven earthquakes and earth tremors were registered by the seismographs at the observatory at Toledo, Spain. Those on July 17 (epicentral distance 112·5°), 19 (epicentral distance 119·1°), and 27 registered the greatest amplitudes at Toledo, whereas the shock on July 18 may have been a local tremor. At Wellington, New Zealand, during the same month, five strong shocks were registered. On July 10 the shock is thought to have originated south of the Kermedecs. On a basis of instrumental evidence received from thirteen other stations, the United States Coast and Geodetic Survey has estimated the epicentre of the shock of July 27 at 0h. 04·2m. G.M.T. to have been near 54·5° N., 166·5° W., which is in the Aleutian Islands, and the depth of focus to have been rather greater than normal. In New Zealand during July fourteen shocks were reported as having been felt. The greatest of these were of intensity 4 on the Modified Mercalli scale, and occurred on July 1 at Opotiki and Whakatane, and on July 11 at Karamea and Westport.

## American Telephone and Telegraph Co.: Fellowships

THE American Telephone and Telegraph Company has established a trust fund to finance post-doctorate fellowships in physical science in honour of Dr. Frank B. Jewett, president of the U.S. National Academy of Sciences and vice-president of the Company in charge of development and research, who has just retired, having reached the Company's retirement age. Five fellowships will be awarded annually. The object is to stimulate and assist research in the fundamental physical sciences, and particularly to provide the holders with opportunities for individual development as creative workers. The fellowships provide an annual honorarium of 3,000 dollars to the holder and 1,500 dollars to the institution at which the recipient elects to do research. The fellowships will enable their recipients to devote themselves to research in pure science for a year or two following their doctorates. Since the purpose is to provide

fungus or bacterial parasites the right-hand column gives the name of the causative agent, for example, mosaic virus, manganese deficiency, irregular water supply, etc. There is one important change in lay-out as compared with previous lists, this being the fact that the host plants instead of being arranged in groups, such as fruits, vegetables, etc., are now all placed in alphabetical order according to their names as ordinarily used. The result is that there is no need for a host-plant index.

In the case of the more important diseases which are also prevalent abroad, foreign common names from several countries are given in slightly smaller type under the selected British common names. There are an index of authors' names and abbreviations, one of the accepted scientific names of both host plants and parasites, and one of foreign common names of various diseases. Many readers will note and approve the separate index providing common names of diseases in Russian.

This attempt at uniformity in nomenclature of diseases is to be commended in a field where confusion is still too often met with. The fact that changes repeatedly occur in the scientific names of plant disease parasites makes this list doubly important to workers in this subject, and the Committee deserves the thanks of both research and advisory plant pathologists for providing such an up-to-date book of reference. There is no doubt that it will be welcomed by all concerned with plant diseases throughout the British Empire.

D. E. Green.

# FOOD HABITS

## The Origin of Food Habits

By H. D. Renner. Pp. 261. (London: Faber and Faber, Ltd., 1944.) 15*s.* net.

Almost the last habits anyone will give up are his food habits. So the average man is the despair of the dietitians and the Ministry of Food, who wish him to eat what is 'good for him' or what foods are available.

In the matter of food habits there are two sharply divided schools of thought: the one which we may call the 'Marie Lloyd school', which believes that food habits are based upon instinct and that what a man fancies does him good; and the other which considers all food habits conditioned reflexes due to upbringing. Most dietitians belong to the latter school. Any digestible substance which can provide calories, proteins, mineral elements and vitamins they call a food, whether the eater likes it or not. He can, they say, acquire a conditioned reflex for that food by practice, and quote illustrations from the War of 1914–18, when children brought up to eat margarine during the War refused butter when it became available after 1918. They also bring in observations made by explorers and anthropologists such as Stefánsson[1] and Margaret Mead[2]. The 'Marie Lloyd school' retort with Pavlov's own work on the psychic flow of gastric juice evoked by pleasant foods in dogs and the extension of Pavlov's work to man by Carlson. Moreover, there is Carl Richter[3], who has brought evidence to bear that Baltimore children behave towards cod liver oil as if guided by need rather than by conditioned reflexes.

The book under review collects evidence which will be used by both schools. The writer, who is rather heavily Teutonic in his handling of the problem, puts his emphasis on experimental psychology. For example, he thinks that people who are fond of food gobble it because they do not want to fatigue the sensory organs, and that when a food "goes round and round" in the mouth it is because the eater wishes to fatigue his gustatory apparatus for the unwanted food, so that he can swallow it without nausea. Surely simpler physiological explanations will cover both cases ?

Though there is much in this book which every person interested in food, whether from gastronomic or dietetic reasons, will disagree with, it is one which every such person should read. It is difficult to sum up its attributes, and perhaps the best way to describe it is to borrow what Dr. Johnson is supposed to have said of the haggis: it is fine confused feeding.

V. H. Mottram.

[1] Stefánsson, "The Friendly Arctic" (Macmillan and Co., Ltd., 1921).
[2] Mead, "The American Character" (Penguin Books, Ltd., 1944).
[3] Richter, "The Harvey Lectures" (Science Press Printing Co., 1943).

# PROF. THE SVEDBERG

## The Svedberg, 1884–1944

Pp. 732. (Uppsala: Almquist and Wiksells Boktryckeri A.-B., 1944.) n.p.

In universities, as in other walks of life, the personal expression of gratitude and appreciation is a rare event, and the means and opportunities of expression both difficult and infrequent. This volume was compiled by colleagues, friends and pupils to celebrate the sixtieth birthday of The Svedberg. If the limitation of war had not been imposed on the compilation, contributions would certainly have come in from all parts of the world.

Svedberg's original work lay in the field of colloid chemistry; but in 1923, as a result of a visit to Wisconsin, his interests were aroused in the possibilities of an ultra-centrifuge. While it is the development of this as an instrument of precision that gained for Svedberg his international reputation as well as a Nobel prize, his interests and activities are in fact much wider. Although he is by title professor of physical chemistry, it is significant that no less than thirty-one of the fifty-six communications in this volume lie in the field of what may now be termed biophysics. Another significant trend emerges in studying this volume—one which doubtless has been accentuated by the War, but which is a real part of the activities of the Institute—namely, the part played by Svedberg and his colleagues in the national economy of Sweden by co-operation with industries to the great advantage both of science and technology.

The volume contains a brief account of the Institute of Physical Chemistry at Uppsala, together with a number of original papers from the various departments of the University. Communications from other universities and high schools, notably the University of Lund, as well as from industrial laboratories are included. The topics dealt with cover a wide field of chemistry and biology, several of them naturally dealing with supercentrifugical, optical and electrophoretic measurements of biological material.

This collection of papers may be regarded as a cross-section of Swedish activities in chemical research during the war period, and any country might well be proud of such work and of The Svedberg, whose influence in and beyond the confines of Sweden has been so profound.

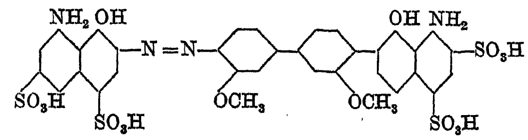
Eric K. Rideal.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Wharton's Jelly Considered as a Conducting Path

DURING the course of experiments conducted on the sheep fœtus, dyes were injected into the umbilical cord with the object of exploring movements of substances in the cord along non-vascular pathways. The dyes used were a dis-azo dye,



related to trypan blue, and the same dye linked to serum albumin by a diazo linkage. The dye, when linked to protein in this way, cannot dissociate from the albumin, and hence acts as a tag to the protein. These substances were prepared by one of us (P.D.M.).

Fœtuses of different age periods were delivered by Cæsarean section and kept alive, with the placental site intact, and the mother alive, for periods up to five hours. The fœtuses were not allowed to breathe. 2–5 ml. of the dye solution was injected under low pressure into Wharton's jelly (avoiding the main umbilical vessels) four to five inches from the abdominal wall of the fœtus. The injection occupied approximately one minute. The injection mass passed slowly along the cord into the abdomen of the fœtus. At the end of three hours, the blue colour of the dye was well marked throughout the whole substance of the cord on the fœtal side of the injection site, over the allantois, the upper portion of the bladder, the umbilical arteries and the adjacent peritoneal reflexions. No coloration was observed along the pathway to the liver or any other site. It is clear, therefore, that the dye did not find its way into either of the three other escape routes from the cord, namely, (1) the vascular system (there are small vessels in the Wharton's jelly of the sheep as was shown by Tait); (2) the allantoic duct, in which case the dye would have appeared in the bladder; (3) the extra embryonic cœlom leading to the *inside* of the peritoneal cavity.

It is therefore evident that molecules as large as serum albumin may pass from the cord into the embryo by a pathway which is functionally and embryologically distinct from routes (1), (2) and (3) above. The molecules of albumin move at a much greater rate than could be accounted for by diffusion. There must, therefore, under the conditions of these experiments, be a bulk flow of fluid from the cord into the embryo. As the pressure available cannot have been large, the resistance to flow through the connective tissue must be small.

Tait[1] reported results of injection into the cord which are different from the results we obtained. It is possible that the differences are due to his dyes being much more coarsely particulate than those used here.

The interest in the above observations lies in the fact that the Wharton's jelly in the umbilical cord of the sheep is continuous with similar material in the cotyledons of the placenta (Barcroft and Barron), implying a path from the placenta to the fœtus other than the purely vascular one. It has yet to be discovered whether material can pass in the fœtus further than the restricted area which we have described. Clearly, if there is a continuous flow of fluid, the water at least must do so, but what sized molecules it can take with it is another question.

Further research is required to ascertain how far this non-vascular pathway in the cord is of importance in the fœtus.

We are deeply indebted to Dr. D. V. Davies for his kind advice on the anatomical problems involved.

J. BARCROFT.
J. F. DANIELLI.
W. F. HARPER.
P. D. MITCHELL.

Unit of Animal Physiology (Agricultural Research Council), Departments of Biochemistry and Zoology, Cambridge, and the Department of Anatomy, London Hospital Medical College.

[1] Tait, L., *Proc. Roy. Soc.*, **24**, 417 (1875).

## Production of Gliotoxin by *Trichoderma viride*

GLIOTOXIN was first described by Weindling and Emerson[1] as a metabolic product of *Trichoderma lignorum* (Tode) Harz [= *T. viride* Pers. ex Fries]. Weindling afterwards[2], on the advice of C. Thom and M. Timonin, reported that he had described the fungus incorrectly, and that instead it should be identified as a *Gliocladium*, similar to *Gliocladium fimbriatum* Gilman and Abbott. I have found that strains of *Trichoderma viride* produce gliotoxin, and I suggest that it is extremely probable that the fungus used by Weindling was not *G. fimbriatum*, but was a *Trichoderma* as he originally supposed.

In 1942 I received from Prof. H. Raistrick a culture which had been supplied to him as Weindling's strain of *G. fimbriatum*. Using the culture medium recommended by Weindling and Emerson[1], I have found this to produce gliotoxin in 4-day still cultures at the rate of about 50 mgm. per litre. Afterwards, in the course of examination of a number of isolates of *T. viride*, one isolated from a local soil (No. 211) was found to possess marked powers of antagonism to a number of bacteria and fungi. This organism was then found to produce gliotoxin in yields of about 95 mgm. per litre, that is, at twice the rate of 'Weindling's strain' under similar conditions.

Analyses (Weiler and Strauss) of the products from both fungi agree with $C_{13}H_{14}N_2S_2O_4$ as found for gliotoxin by Dutcher[3], not with $C_{14}H_{16}N_2S_2O_4$ as originally suggested by Weindling and Emerson. Data are given in Table 1.

TABLE 1.

| % | Calc. for $C_{13}H_{14}N_2S_2O_4$ | Gliotoxin from Strain No. 211 | Gliotoxin from 'Weindling's strain' |
|---|---|---|---|
| C | 47·8 | 47·8 | 47·8 |
| H | 4·3 | 4·4 | 4·4 |
| S | 19·7 | 19·9 | 19·8 |
| N | 8·6 | 8·3 | 8·6 |

Until I discovered the production of gliotoxin by a fungus which I considered to be an obvious *Trichoderma*, I accepted the nomenclature of 'Weindling's strain' as *G. fimbriatum* Gilman and Abbott. Since these two fungi appeared very similar in macro-

scopic cultural characteristics, a more detailed examination of the two isolates was made. Apart from minor cultural differences, such as the relative amounts of sporulation on different media, the two were very similar morphologically. Fortunately, I was able at the same time to obtain another culture of *Gliocladium fimbriatum* Gilman and Abbott from the National Collection of Type Cultures (*NCTC.* No. 6599). This was clearly different from the two isolates mentioned above, and I have not been able to demonstrate the production of gliotoxin by this fungus. In Table 2 certain morphological features of these three fungi are compared with the original description of *G fimbriatum* by Gilman and Abbott[4].

TABLE 2.

| | *G. fimbriatum* (data from Gilman and Abbott[4]) | *G. fimbriatum. NCTC.* 6599 | *G. fimbriatum.* 'Weindling's strain' | *T. viride* No. 211 |
|---|---|---|---|---|
| Conidia | 6·5–9·5 × 2·5–4 μ | 5·5–7·5 × 3–3·5 μ | 4·4–5·2 × 3·5–4·5 μ | 4·5–5·5 × 3·5–4·5 μ |
| Phialides | 10–20 μ | 14–20 μ | 7–11 μ | 7–10 μ |
| Chlamydospores | Not recorded | None | Abundant | Abundant |

It will be seen that 'Weindling's strain' and my isolate of *T. viride* are similar, and that both differ from *G. fimbriatum* (*NCTC.* 6599) and from Gilman and Abbott's description of *G. fimbriatum* in having shorter phialides, smaller and less markedly elliptical conidia, and in possessing chlamydospores of a type invariably found in *Trichoderma*. The conidia of *G. fimbriatum* (*NCTC.* 6599) are borne in slime-balls on a polyverticillate penicillus typical of the genus, usually more complex than that figured by Gilman and Abbott. The spore-balls of 'Weindling's strain' and *T. viride* No. 211 are borne at times on single phialides, or on two to three phialides, arising from the conidiophores in a manner typical of *T. viride*, but a high proportion are borne on phialides arising from a group of branches or metulæ produced terminally on the conidiophores, giving a rather *Gliocladium*-like appearance. Nevertheless, the characters already mentioned, the formation of 'tufts' of conidiophores, the rapid growth, and general colony characteristics all point to 'Weindling's strain' and my isolate No. 211 being strains of *T. viride*. They are aberrant strains in so far as the formation of a rather complex conidiophore is concerned; but, as Bisby[5] has shown, *T. viride* exhibits considerable strain variation in several directions.

It seems clear, from the evidence given above, that the fungus obtained as Weindling's strain of *Gliocladium fimbriatum* is really a strain of *Trichoderma viride*. Moreover, Weindling[2] himself mentions that the conidia of his organism were smaller than those recorded for *G. fimbriatum* Gilman and Abbott, and that it produced chlamydospores similar to those of *Trichoderma*, which had not been recorded by Gilman and Abbott for *G. fimbriatum*.

Antagonism based on the production of antibiotics is probably of great importance in determining the balance between various micro-organisms in such habitats as soil. It seems probable that the well-known antagonistic powers of *T. viride* are due, at least in part, to the production of gliotoxin. The natural biological role of gliotoxin can now be regarded as much greater than was heretofore imagined, since *T. viride* is widespread and abundant in soil, unlike the relatively rare *G. fimbriatum*.

Thanks are due to Dr. G. R. Bisby for help in the nomenclature of some of the organisms studied, and to Mr. J. C. McGowan for the chemical identification of gliotoxin.

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[1] Weindling, R., and Emerson, O. H., *Phytopath.*, **26**, 1068 (1936).
[2] Weindling, R., *Phytopath.*, **27**, 1175 (1937).
[3] Dutcher, J. D., *J. Bact.*, **42**, 816 (1941).
[4] Gilman, J. C., and Abbott, E. V., *Iowa State Coll. J. Sci.*, **1** (3), 225 (1927).
[5] Bisby, G. R., *Trans. Brit. Mycol. Soc.*, **23** (2), 149 (1939).

## Carcinogenic Effect of Aminoazobenzene

SINCE Kinosita[1] first showed that rats developed malignant tumours of the liver when fed a deficient diet containing N,N-dimethyl-*p*-aminoazobenzene (butter-yellow), much work has been done in an attempt to elucidate the mechanism whereby this azo-dye brings about neoplastic changes in liver tissue. One aspect studied has been the metabolism of the dye itself; Stevenson, Dobriner and Rhoads[2] were able to isolate *p*-aminophenol and *p*-phenylenediamine, and also their N-acetylation products, from the urine of rats receiving the dye orally. Thus the azo-link is split as in the case of *o*-aminoazotoluene[3] and other azo-compounds in the animal body. However, the absence of N,N-dimethyl-*p*-phenylenediamine from fractions prepared without addition of sodium hydrosulphite suggested that complete demethylation occurs at some stage prior to the acetylation of the *p*-phenylenediamine. This lability of the N-methyl groups has been neatly demonstrated by Jacobi and Baumann[4], who found butter-yellow could function like other methyl-donors in protecting young rats against kidney lesions when on a choline-free diet.

Jacobi and Baumann[4] also suggested that the protection afforded by high-protein and high-riboflavin diets against butter-yellow carcinogenesis was due, at least in part, to the demethylation of the dye to *p*-aminoazobenzene, which they quote Kinosita as stating is non-carcinogenic. Kensler, Dexter and Rhoads also state that "Aminoazobenzene . . . does not produce liver cancer in the rat". This would attribute to the methyl groups a dominant role in the process of carcinogenesis. However, the methyl groups in *o*-aminoazotoluene (which is more carcinogenic for mice than is butter-yellow[6]) are attached to carbon atoms and presumably are not labile. Hence, it seemed unlikely that the N-methyl groups of butter-yellow were so essential as these workers suggested, and that *p*-aminoazobenzene itself might really be carcinogenic.

Miller, Miner, Rusch and Baumann[7] evolved a low-protein basal diet which enabled them to induce hepatomas in 90–100 per cent of rats receiving a butter-yellow supplement for four months; the incidence on a full diet was only 80 per cent at eight months. A group of fifteen albino rats of Wistar origin were placed on a similar diet in this Department, except that starch was replaced by boiled potatoes as a war-time modification. This modified diet, supplemented with butter-yellow (0·06 per cent of diet), induced malignant liver tumours after seven months, that is, it caused no marked acceleration

in the production of tumours, compared with a full diet. However, sixteen similar rats have been fed on this modified diet, supplemented with *p*-aminoazobenzene (at first 300 mgm. per 100 gm. diet, and, later, 200 mgm. per 100 gm. diet), for more than eighteen months, so far. Of eight rats now dead, one (dying at thirteen months) had a few whitish spots visible to the naked eye, in the liver, and these proved on microscopic examination by Dr. P. R. Peacock to be small hepatomas. Two other rats died at seventeen months, both having very large tumours in one lobe and smaller tumours in the other lobes of the liver; in one case, the liver weight (including tumours) was 47·8 gm. These tumours were liver-cell carcinomas which were metastasizing via blood-vessels to the mesentery. It is hoped to publish, in conjunction with Dr. P. R. Peacock, a full account of the pathology of these lesions elsewhere; but it may now be said that *p*-aminoazobenzene is carcinogenic for rats fed the dye in a somewhat restricted diet for a long time.

This finding is in accordance with the results obtained by Kensler *et al.*[5,8] and Potter[9], who found various enzyme systems to be inhibited by the *p*-diamines which are liberated from butter-yellow and related azo-dyes when the azo-link is reduced. Thus N,N-dimethyl-*p*-phenylenediamine caused 64 per cent inhibition of urease at a molarity of $1 \times 10^{-3}$. *p*-Phenylenediamine at the same concentration caused 45 per cent inhibition[9]. Similarly, in the cases of succinoxidase, yeast carboxylase and coenzyme-I, *p*-phenylenediamine caused a significant degree of inhibition. If this effect on enzymes plays a part in the process of liver carcinogenesis, then it would be reasonable to expect that aminoazobenzene would be carcinogenic, though less so than the fully methylated compound. This is what we have found to be the case. It is, moreover, clear that the butter-yellow split-product must have its effect prior to the demethylation process, that is, reduction of the azo-link must precede demethylation; otherwise the two dyes would eventually yield the same split-product, *p*-phenylenediamine, and have the same degree of carcinogenic power.

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[1] Kinosita, *Trans. Jap. Path. Soc.*, **27**, 665 (1937).
[2] Stevenson, Dobriner and Rhoads, *Cancer Res.*, **2**, 160 (1942).
[3] Hashimoto, *Gann.*, **29**, 306 (1935).
[4] Jacobi and Baumann, *Cancer Res.*, **2**, 175 (1942).
[5] Kensler, Dexter and Rhoads, *Cancer Res.*, **2**, 1 (1942).
[6] Law, *Cancer Res.*, **1**, 397 (1941).
[7] Miller, Miner, Rusch and Baumann, *Cancer Res.*, **1**, 699 (1941).
[8] Kensler, Young and Rhoads, *J. Biol. Chem.*, **143**, 465 (1942).
[9] Potter, *Cancer Res.*, **2**, 688 (1942).

## Taste of Thiouracil and Phenylthiocarbamide

TWELVE years ago, Fox[1] discovered a curious property of phenylthiocarbamide. He was putting some of the substance into a bottle when a colleague complained of the extremely bitter taste, which Fox himself was unable to confirm. The question was investigated by Blakeslee[2], who found that a sample of the American population contained 40 per cent of individuals who were non-tasters. Furthermore, it was found that if two non-tasters married, their children were also non-tasters. The ability to taste ($T$) is dominant to non-tasting ($t$), so that parents having the constitution $Tt$ may have non-tasting children; but if one of them is homozygous, $TT$, then all the children will be tasters of phenylthiocarbamide. The test has been used as a genetic marker in the investigation of human pedigrees[3,4,5].

As the chemical constitution of thiouracil and phenylthiocarbamide indicate a common origin, it was considered desirable to investigate the taste of the former. Sixty volunteers submitted to the tests. Approximately one half of a 0·2 gm. tablet of thiouracil was chewed, and the subject was asked to state what taste it had. The responses varied from intensely bitter to a chalky taste, but there was no difficulty in identifying the tasters from the non-tasters. A solution of phenylthiocarbamide was prepared containing 0·005 per cent, and the subjects were given a teaspoonful each. This solution divided the group into two, tasters and non-tasters, in the same manner as the thiouracil, with one exception. This was a male who considered that thiouracil was intensely bitter, but was unable to taste 0·005 per cent phenylthiocarbamide although a 0·01 per cent solution was tasted. He was considered to be a taster.

| | Tasters | Non-tasters | Total |
|---|---|---|---|
| Males | 23 | 10 | 33 |
| Females | 20 | 7 | 27 |
| Total | 43 | 17 | 60 |

The proportion of tasters to non-tasters is shown in the accompanying table. The numbers were too small to establish the excess of non-tasting males which is known to occur. The material included a female taster who had a non-tasting husband. They have two children, a non-tasting boy and a tasting girl. It follows that the woman is probably heterozygous ($Tt$) for the factor concerned in controlling the taste of both thiouracil and phenylthiocarbamide. Two identical twins were both tasters.

It would appear that the ability to taste thiouracil is inherited in the same manner as that of phenylthiocarbamide. A few subjects taking thiouracil therapeutically showed nothing to suggest that their response differed in any way from the majority. So far as our knowledge goes, this peculiar property has only genetic significance.

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[1] Fox, A. L., *Proc. U.S. Nat. Acad. Sci.*, **18**, 115 (1932).
[2] Blakeslee, A. F., *Proc. U.S. Nat. Acad. Sci.*, **18**, 120 (1932).
[3] Boyd, W. C., and Boyd, L. G., *Ann. Eugenics*, **8**, 46 (1937).
[4] Riddell, W. J. B., *Trans. Ophth. Soc.*, **59**, 275 (1939).
[5] Riddell, W. J. B., *Ann. Eugenics*, **10**, 1 (1940).

## Apparent Vitamin C as a Possible Precursor of True Vitamin C in Walnuts

UNRIPE walnuts have previously been reported[1,2] to contain considerable amounts of apparent vitamin C, the provisional term suggested[3] for substances which so closely resemble true vitamin C in chemical and physical properties that they may be confused with the latter when it is being estimated by the usual dye titration method, though they may be distinguished from it by modifications[4,5] of Lugg's

formaldehyde method[6]. A detailed study (on some hundreds of samples) has now been made of the relative proportions of true and apparent vitamin C in different tissues of the walnut throughout the period of growth and ripening.

The fruit in the earliest stages may contain practically no true vitamin C but very high concentrations (more than 1,000 mgm. per 100 gm.) of apparent vitamin C. As growth and maturation proceed, the proportion of true vitamin C in the total vitamin C gradually increases until in the nearly ripe nuts it approaches 100 per cent. An explanation is thus provided of the lower proportions of apparent vitamin C found by other workers[4,7,8] who examined more mature nuts. Moreover, the apparent vitamin C also occurs in high concentration in buds and leaves, and the concentration gradients suggest that a steady flow occurs from these centres of photosynthetic activity to the tissues of the nut in which it may be converted into true vitamin C. The most striking results have been obtained with samples of *Juglans regia*. With *J. nigra* the results were similar but less marked, and with *J. rupestris* and *Carya ovalis* var. *obcordata* the part played by apparent vitamin C is more obscure. This season no specimens were available of *J. cinerea*, in which we found last year that 73 per cent of the total vitamin C was apparent vitamin C.

Our results in the 1943 season had already indicated the possibility that apparent vitamin C might be a precursor of true vitamin C in walnuts[9], and our results in 1944 have provided further evidence in favour of this hypothesis. Attempts to establish the identity of the apparent vitamin C in walnuts are meeting with certain difficulties, and until these are overcome it appears premature to discuss various interesting possibilities arising from our findings. However, we think it desirable to publish this preliminary note and thus afford other workers the opportunity of checking our results.

The possible presence in apples of a vitamin C precursor has recently been mentioned by West and Zilva[10] when describing the results of several years work in which clear evidence was obtained that the true vitamin C content may increase during storage. It would be of interest to discover whether their apples contain any apparent vitamin C and, if so, whether the proportion of this decreased as the proportion of true vitamin C increased, as should occur if the former is a precursor of the latter. Unripe walnuts do not withstand storage so readily as apples do, and we have not yet been able to duplicate with our walnuts West and Zilva's lengthy storage experiments on apples. Over short periods (of a few weeks) we have obtained evidence with walnuts of decreases in the concentration of apparent vitamin C in parallel with increases in concentration of true vitamin C which were of the order to be expected from West and Zilva's results; but so far there has not been a high degree of significance in the differences observed.

Whether further work succeeds or fails in proving apparent vitamin C to be a precursor of true vitamin C, there already seems to be clear evidence that, in walnuts at least, apparent vitamin C is not a mere degradation product such as might be formed during the processing of foods, but rather a substance playing an important part in plant metabolism. The question of the part, if any, which it plays in animal metabolism, and of its possible physiological activity, has still to be decided.

We are indebted to Dr. E. J. Salisbury, director of the Royal Botanic Gardens, Kew, for material, to Prof. R. A. Morton for advice and for spectrographic examination of our extracts, to Dr. Bergel of Messrs. Roche Products, Ltd., for specimens of reductone, reductic acid and hydroxytetronic acid which we have compared with the apparent vitamin C in walnuts, and to Miss Elaine Finnigan and Miss Valerie Pritchard for assistance in making the extracts.

Full details of this work will be published elsewhere.

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[1] Melville, Wokes and Organ, *Nature*, **152**, 447 (1943).
[2] Wokes, Organ, Duncan and Jacoby, *Biochem. J.*, **37**, 695 (1943).
[3] Wokes, Organ, Duncan and Jacoby, *Nature*, **152**, 14 (1943).
[4] Mapson, *J. Soc. Chem. Ind.*, **62**, 223 (1943).
[5] Wokes, Organ, Duncan and Jacoby, *J. Soc. Chem. Ind.*, **62**, 232 (1943).
[6] Lugg, *Aust. J. Exp. Biol. and Med. Sci.*, **20**, 273 (1942).
[7] Taylor, *Biochem. J.*, **37**, 54 (1943).
[8] Lugg and Weller, *Nature*, **152**, 448 (1943).
[9] Ovaltine Research Laboratories Annual Report, 1943, p. 5.
[10] West and Zilva, *Biochem. J.*, **38**, 105 (1944).

## Thymol Turbidity Test: a New Indicator of Liver Dysfunction

IN the course of work on the serum colloidal gold reaction[1,2] it was noted that the thymol which was at first used to inhibit the growth of moulds in the barbitone buffer ($p$H 7·8) produced a marked turbidity or precipitate with certain sera. These sera were usually from patients with parenchymatous liver disease and also gave positive colloidal gold reactions, and it soon became evident that there was a close correlation between the thymol turbidity and the gold test. Phenol and many of its substitution products gave similar results in suitable concentrations, and there was a direct relationship between the molecular weight, the solubility and the precipitating power. Thus six typical compounds required the following concentrations to produce equal degrees of turbidity at $p$H 7·8, $\mu = 0{\cdot}01$, when added to serum from a case of infective hepatitis. In each case the same solutions produced negligible effects with normal serum.

| Compound | Equivalent concentration | Molecular weight | Solubility (approx.) |
|---|---|---|---|
| Phenol .. .. | 1·5 per cent | 94 | 5·1 per cent |
| Cresols (*o*, *m* and *p*) | 0·75 ,, | 108 | 1·8–2·5 ,, |
| Xylenol (1, 2, 4) .. | 0·4 ,, | 122 | 0·79 ,, |
| Naphthol ($\alpha$) .. | 0·10 ,, | 144 | 0·11 ,, |
| Thymol .. .. | 0·11 ,, | 150 | 0·11 ,, |
| Carvacrol .. .. | 0·11 ,, | 150 | 0·12 ,, |

It is evident that in this series, with increasing molecular weight, the solubility falls off more rapidly than the concentration required for effective precipitation, so that higher homologues such as cholesterol are too insoluble to give a positive result. These considerations suggest analogies with the Pandy test for globulin in cerebrospinal fluid which uses saturated phenol solution, and with the cephalin-cholesterol flocculation test of liver function[3]. It

seems extremely probable that both these tests depend upon the same principle, the function of the cephalin being to keep the cholesterol in solution. On this basis thymol occupies a convenient intermediate position for use with serum, as it is just soluble enough to produce a satisfactory result in saturated solution. Being effective in low concentration, it has the additional merit of simplifying the analysis of the precipitate. No other compound tested was superior to thymol.

As with the gold reaction, changes in the $p$H and in the ionic strength of the medium exerted a marked influence on the result, so that at $p$H 5 turbidity was increased but the test lost all specificity. After numerous trials the following technique was finally adopted and has now been used in some 450 cases.

*Thymol buffer*, *pH* 7·8, $\mu = 0{\cdot}01$. Add 500 ml. of water to 1·03 gm. of sodium barbitone, 1·38 gm. of barbitone, and approximately 3 gm. of thymol. Heat just to boiling point, shake well and cool thoroughly. The mixture should now be turbid. Seed with a small amount of powdered thymol crystals, shake and allow to stand overnight at a temperature of 20–25° C. Finally shake again and filter the clear solution from the crystalline deposit.

*Method*. Add 60 volumes of buffer to 1 volume of serum, allow to stand for half to one hour and compare in a comparator with the turbidity standards of Kingsbury *et al.*[4]. 3 ml. of buffer and 0·05 ml. of serum are convenient volumes to use. The standards are those in common use for urine protein estimation and can be obtained commercially[5]. If the turbidity exceeds the 100 mgm. per cent standard, dilute with a further measured volume of buffer as required. When the test is positive, flocculation frequently occurs on standing overnight, but this is not an essential part of the test. The result is recorded in arbitrary units equal to the appropriate standard divided by ten with allowance for dilution. Thus if the final dilution is 1 in 120 and the mixture then matches the 70 mgm. per cent tube, the result is 14 units. Normal sera give values from 0 to 4 units.

The precipitate in typically positive cases contained 6·0 per cent N, 0·33 per cent P, 32 per cent thymol, and 11·8 per cent cholesterol (average figures). It could be redissolved in weak alkali and was then completely precipitated with one-third saturated ammonium sulphate. It therefore appears to be a globulin-thymol-lipoid complex with the following average composition: protein 37·5 per cent, thymol 32 per cent, cholesterol (half esterified) 16·5 per cent, and phospho-lipid calculated as lecithin 8·0 per cent. The protein is probably mainly the gamma globulin which is known to be concerned with the cephalin-cholesterol test and with the gold reaction[6]. The chemistry of the test is not understood; but it appears that the phenolic grouping has a special affinity for gamma globulin under the conditions employed, although other proteins are precipitated at more acid reactions or with higher concentrations of precipitant. The total serum globulin is above normal in about half the cases with positive thymol tests.

A fuller account will appear elsewhere. In general, the results have been similar to those obtained with the serum colloidal gold reaction[1,2], being positive in 120 out of 130 cases of infective hepatitis (mean 10·3 units, standard error 0·44), in 13 out of 13 cases of cirrhosis ($14{\cdot}2 \pm 2{\cdot}0$), and only weakly positive in 3 out of 38 cases of obstructive jaundice ($1{\cdot}2 \pm 0{\cdot}27$). The thymol test was more often positive than the gold test in Weil's disease and was less often positive in chronic infections. It is therefore rather more specifically related to liver disease than is the gold test, and should be of value in the differential diagnosis of jaundice and as a general indicator of liver dysfunction.

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[1] Maclagan, N. F., *Brit. J. Exp. Path.*, **25**, 15 (1944).
[2] Maclagan, N. F., *Brit. Med. J.*, ii, 363 (1944).
[3] Hanger, F. M., *J. Clin. Invest.*, **8**, 261 (1939).
[4] Kingsbury, Clark, Williams and Post, *J. Lab. and Clin. Med.*, **11**, 981 (1926).
[5] King, E. J., and Haselwood, G. A. D., *Lancet*, ii, 1153 (1926).
[6] Kabat, E. A., Hanger, F. M., Moore, D. H., and Landow, H., *J. Clin. Invest.*, **22**, 563 (1943).

## Barotaxis in Diptera, and its Possible Significance to Economic Entomology

VARIOUS authors have noted an apparent correlation between the degree of activity of insects and the barometric pressure. I have recently completed an investigation of the conditions governing the aerial distribution of insects. The completed work is to be published elsewhere, but it has been thought advisable to direct attention to a phenomenon which came to light during laboratory experiments on the effects of decreased pressure upon insects.

It was noted that certain insects, particularly Diptera, consistently reacted to slight decreases in pressure with a marked increase in flight activity. This increase in activity occurred within the pressure range corresponding to the height interval between sea-level and about 1·5 km. The activity again became normal at still lower pressures.

It must be stressed that this increasing activity is not a distress reaction. The increase occurs regardless of the rate of decrease in pressure, within a zone of reasonable temperature. It occurs when ample time is allowed for acclimatization at given pressure levels.

Not all orders of insects exhibit such a response. In the case of the Diptera, the response is so marked that it should be considered of barotaxic origin. At the present time, the underlying physiology is not clear. However, Glick[1], in commenting on the results of his aircraft collections, notes that Diptera were taken in the first 1·5 km. of the atmosphere in consistently greater numbers than were any other orders. Since the collections were made under a variety of weather conditions, it does not seem reasonable to account for the above simply by assuming numerical superiority. Moreover, species of Coleoptera and Hymenoptera were the next most abundant within this height-interval. It may be significant that these three orders possess highly developed nervous systems. It is probable that their consistent occurrence at higher elevations arises from a favourable response to lowered pressure rather than from sheer weight of numbers.

Although the above observations are chiefly related to the distribution of insects in the upper air, they may be of value when applied to the bionomics of dipterous species at the surface. Underhill[2] noted that certain Simuliids fed more actively at low pressures, or during periods of rapidly falling pressures. It is likely that this is another manifestation of the general increase in activity.

I would suggest that, in future, more attention be given to the correlation of surface pressures with field observations of dipterous species, particularly in those problems related to variations in the activity of Diptera attacking man and animals. By a consideration of the surface pressure distribution, it may be possible to forecast changes in the activities of adults in the field, provided the temperature and other factors are favourable to activity. In this regard, the effect of the winds around areas of low pressure should be considered.

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[1] Glick, P. A., *Tech. Bull., U.S. Dept. Agric.*, No. 673 (1939).
[2] Underhill, G. W., *J. Econ. Ent.*, 33 (6), 915 (1940).

## Phase Difference Microscopy

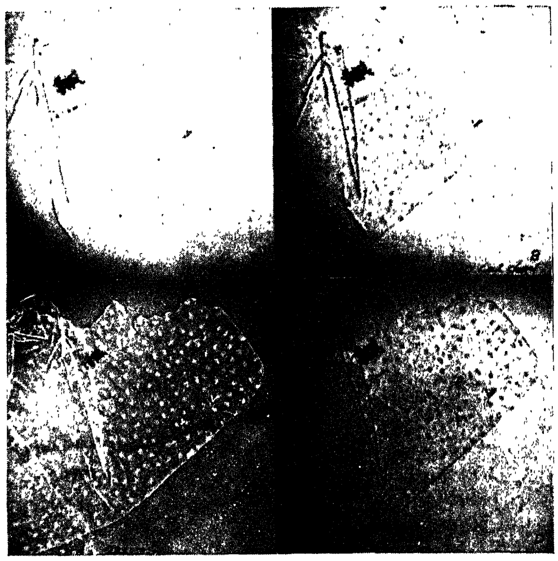
THE microscope does not reveal detail in uncoloured, transparent specimens even though it is known to be present and of sufficient size to be resolvable. When the detail includes regions of different refractive index, phase differences will be involved in light passing through the specimen, and if these phase differences are changed into intensity differences, the detail may be seen since the eye is sensitive to the latter although not to the former.

This change can be accomplished by inserting an annular stop into the condenser of the microscope and inserting a phase plate into the objective at its back focal plane. The phase plate consists of an annulus having a different transparency from the rest of the plate and of proper size to intercept the light coming directly from the opening in the condenser. The plates can be made so that the detail in the specimen may be seen either brighter or darker than its surroundings.

Abbe considered phase differences, but made little practical use of them. Conrady and Rheinberg[1] used phase difference microscopy to show and photograph a grating. Zernike[2] extended the treatment of these differences and urged their use in microscopy. Köhler and Loos[3] used his method with an annular plate and described some of the advantages of this kind of microscopy. The general theory and optical design have been extended in our Research Division by Dr. Harold Osterberg and Dr. R. K. Luneberg, coating methods for the phase plates have been developed by Dr. Helen Jupnik and practical tests and applications have been made by me, all working under Mr. A. H. Bennett, director of research.

The Spencer equipment includes a variety of phase plates having *both* retarding and absorbing properties of improved thin-film coatings. Both positive and negative plates are available for a range of 0–0·4 $\lambda$ retardation and 0–100 per cent transmission. *Absorption differences* have been found by us to be as important as retardation differences in making some specimens visible under the microscope. The microscope exhibited at the Cleveland meetings of the American Association for the Advancement of Science had the phase plates mounted in a disk so that they could be rotated successively into place within the objective.

Phase difference microscopy has been found useful with unstained, transparent tissues, both plant and animal. Fig. 1 shows the appearance of epithelial tissue, living and unstained, from the nictitating



FROG NICTITATING MEMBRANE EPITHELIUM. × 40 APPROX. *A*, ORDINARY MICROSCOPE, APERTURE FILLED. *B*, SAME, APERTURE HALF FILLED, DETAIL LARGELY DIFFRACTION PATTERNS. *C*, BRIGHT-, AND *D*, DARK-PHASE WITH PHASE-DIFFERENCE MICROSCOPE.

membrane of the frog eye. The fine detail in fibroblasts from a chick embryo should be seen, but is not seen with the usual microscope objective. (Stopping the condenser down to give a narrow illuminating cone loses the fine detail in a lot of diffraction patterns.) Bacteria, blood cells, mould and Protozoa can be made clearly visible against their background; this facilitates study and counting. The resolution of the lenses appears not to be reduced, and considerable time and material are saved by not staining the specimens. The 'visualization' of transparent cells will give an interesting check on previous information obtained from killed and stained cells and tissues.

Industrial applications may include the examination of transparent fibres, as glass and plastics, and surface detail on materials embedded in media of slightly different index. Small particles, within the limit of resolution of light microscopy, may be counted and measured, as in homogenized milk and in mayonnaise. The microscopic polishing marks on a transparent glass surface have been demonstrated and photographed in our laboratory.

The positive phase difference giving dark detail is more useful for measurement, and the negative phase showing bright particles is preferable for counting. Either appearance is possible with no damage to the specimen. When the particles are of differing size, as within a large *Paramecium*, they may selectively be made lighter or darker with respect to those of different size. Magnifications used range from 100 to 2,000 diameters and include dry and homogeneous immersion objectives. This development extends greatly the usefulness of the light microscope to include transparent materials of importance to several branches of science, medicine and industry.

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[1] Conrady, A. E., *J. Roy. Micro. Soc.*, 150 (1905). Rheinberg, J., *J. Roy. Micro. Soc.*, 388 (1904); 152 (1905).
[2] Zernike, F., *Z. tech. Phys.*, 16, 454 (1935).
[3] Köhler, A., and Loos, W., *Naturwiss.*, 29, 49–61 (1941).

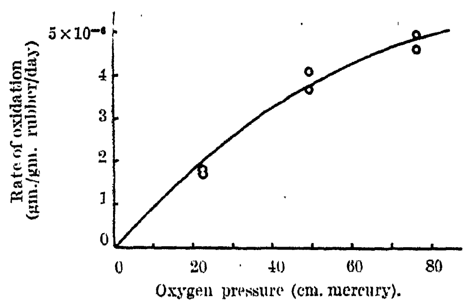
## Reaction between Oxygen and Rubber

SEVERAL investigations[1,2,3,4] on the effect of pressure on the reaction between natural rubber and gaseous oxygen in its initial stages have been made by following the rate of disappearance of the oxygen in a closed system. In the experiments, the oxygen pressure decreased spontaneously as oxygen combined. Under these conditions, the results may be vitiated if time-effects occur such as might arise from the rate of combination of oxygen dissolved in the rubber outpacing the rate of dissolution of fresh gas, or from the formation of unstable oxidation catalysts.

We have carried out oxygen absorption experiments under conditions of constant pressure, with rubber specimens for which we have evidence that their state of subdivision is such as to prevent any complication from diffusion effects, and have come to the following conclusions.

1. At constant pressure the rate of oxidation reaches a constant and reproducible value. (Our experiments have been confined to combined oxygen proportions not exceeding 1 per cent by weight.)

2. Contrary to earlier suggestions[4], the oxidation-rate is greater the greater the oxygen pressure (Fig. 1).




OXIDATION OF UNVULCANIZED SMOKED SHEET RUBBER AT 40° C.

3. The rate of oxidation using dry air free from carbon dioxide is greater than that using undiluted oxygen at the same partial pressure.

The following further conclusions are based on experiments involving alteration in oxygen pressure.

4. After storage in a vacuum, the rate of oxidation of rubber in oxygen under constant pressure slowly increases, for several hours, from zero to the 'equilibrium rate' for that oxygen pressure. This period is considerably greater than that required for solubility equilibrium.

5. If, after the rate of oxidation under constant pressure has become constant, the oxygen pressure is reduced to a new constant value, the rate of oxidation falls slowly for several hours from a high initial value to the new constant rate corresponding with the lower pressure. This high initial rate is sometimes greater than the constant rate at the higher pressure. These statements may also be true in strict converse for an increase in oxygen pressure.

6. The persistence of an oxidation-rate greater than the 'equilibrium rate' immediately succeeding a reduction in pressure (see 5) can invalidate conclusions from experiments involving a changing pressure, and may explain the lack of agreement between results of earlier workers.

A detailed account of this work will be published later.

We wish to thank the Dunlop Rubber Co. for permission to publish this work.

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[1] Williams and Neal, *Ind. Eng. Chem.*, **22**, 874 (1930).
[2] Dufraisse, *Rubber Chem. and Tech.*, **11**, 268 (1938).
[3] Milligan and Shaw, *Proc. Rubber Tech. Conf.* (London), 537 (1938).
[4] Morgan and Naunton, *Proc. Rubber Tech. Conf.* (London), 599 (1938).

## Ethereal Sulphate Content of Agar Specimens

IN 1942, through the kindness of Dr. A. P. Orr of the Marine Station, Millport, specimens of agars of known history were examined to see if evidence could be secured for the formulation of Jones and Peat[1], which demands a relatively high sulphur content (S, 1·8 per cent; that is, $SO_4$, 5·4 per cent).

The specimens had been extracted from the algæ with boiling water without any chemical treatment, and the agars purified by freezing and thawing; the results are tabulated below:

| Plant | Source | Ash | $SO_4$ (in ash) | $SO_4$ (total) |
|---|---|---|---|---|
| *Gracilaria confervoides* | Plymouth | 2·2% | 0·9% | 1·3% |
| *Gelidium crinale* | Dunure (Ayrshire) | 3·6 | 0·7 | 1·4 |

These figures may be compared with those reported by Barry and Dillon[2] for an agar extracted from *Gelidium latifolium*, which gave ash, 2·6 per cent; S, 0·36 per cent. It is clear that none of the above specimens contain sufficient sulphate to account for the proportion of 2 : 4-dimethyl-3 : 6-anhydro-β-methyl-*l*-galactoside (9 per cent[1]; 11·5 per cent[3]) isolated from methylated agar, on the former of which the 'sulphate formula' proposed by Jones and Peat is based.

From their experiments with periodic acid, Barry and Dillon[2] concluded "that the 3 : 6-anhydro-*l*-galactose isolated from agar in the form of its 2 : 4-dimethyl derivative is not an artefact produced during the methylation process[1], but a constituent of the agar molecule". That this appears to be true for commercial samples of agar has been pointed out previously[3,4,5,6], but it is difficult to believe that there is no connexion between the 3 : 6-anhydro-*l*-galactose units and the sulphate groups, since the alkaline hydrolysis of methylhexoside sulphates gives rings of this type[6]. If, as Jones and Peat[1] suggest, all the galactose residues which ultimately become 3 : 6-anhydro-*l*-galactose residues carry sulphuric ester groups at the same time, the present evidence points to the conclusion that most of these sulphate residues are removed at some stage prior to the actual extraction of the polysaccharide from the plant. An alternative view would be a gradual removal of sulphate groups during the life of the plant with 3 : 6-anhydride formation, followed by the formation of ethereal sulphates on other galactose residues, the sulphur content remaining approximately constant throughout.

Finally, it should be stated that there is as yet no direct evidence that the sulphate groups remaining in the agar after isolation are located on $C_6$ of the

$l$-galactose residues, although at the time of the publication by Jones and Peat[1] this was perhaps a natural assumption. The ethereal sulphate could indeed be situated on $C_3$, since recent experiments in this laboratory have shown that methylglucofuranoside-3-sulphates yield 3 : 6-anhydrides on alkaline hydrolysis. It may be added further that if the hydroxyl groups on $C_3$ were thus esterified, the agar would possess no $\alpha$-glycol groupings, and would therefore not react with periodic acid, thus providing an alternative explanation for the results of Barry and Dillon[2]. It should be noted, however, that this suggestion that the sulphate residue might be found on $C_3$ is not put forward as a rival hypothesis to that of Jones and Peat[1], but as a possible alternative, to emphasize the fact that additional work on agar specimens of known history is needed before further progress can be made in determining the structure of this polysaccharide.

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[1] Jones and Peat, *J. Chem. Soc.*, 225 (1942).
[2] Barry and Dillon, *Chem. and Ind.*, **63**, 167 (1944).
[3] Percival and Thomson, *J. Chem. Soc.*, 750 (1942).
[4] Hands and Peat, *Chem. and Ind.*, **57**, 937 (1938).
[5] Forbes and Percival, *J. Chem. Soc.*, 1844 (1939).
[6] Duff and Percival, *J. Chem. Soc.*, 830 (1941).

## Non-conservative Fundamental Particles

IN view of certain possibilities, for example the still open possibility of the non-existence of the neutrino, it may be interesting to set up an equation for a fundamental particle which, in the restricted relativity approximation, does not obey the energy conservation law.

Such a non-conservation property is easily arrived at by taking a Lagrangian which depends explicitly on the four co-ordinates. It is remarkable, however, that such a Lagrangian, or alternatively the corresponding equations, are almost automatically obtained, in an elegant way, by starting from the Dirac form and merely taking full account of the Lorentz invariance. The simplest form of equation is obtained as follows. Let us start from the Dirac equation

$$\gamma^{\mu}\,\partial_{\mu}\,\psi + k\,\psi = 0 \quad (\partial_{\mu} = \partial/\partial x^{\mu}).$$

It is well known that the Lorentz invariance is not altered if one adds a term of the form $A_{\mu\nu}\,\gamma^{\mu}\,\gamma^{\nu}$, $A_{\mu\nu}$ being an antisymmetric tensor of second rank. The simplest tensor of this type attached to the particle is obviously $x_{\mu}\,\partial_{\nu} - x_{\nu}\partial_{\mu}$. In order to make it invariant also under a change of origin, we take $(x_{\mu} - b_{\mu})\,\partial_{\nu} - (x_{\nu} - b_{\nu})\,\partial_{\mu}$, $b_{\mu}$ representing the co-ordinates of a point in space-time, the simplest case again being $b_{\mu} =$ constant. Putting therefore $m^{\mu\nu} = i/2.(\gamma^{\mu}\gamma^{\nu} - \gamma^{\nu}\gamma^{\mu})$, the new equation is, in the case of no field :

$$(1) \quad \gamma^{\mu}\,\partial_{\mu}\,\psi + i\lambda\,(x_{\sigma} - b_{\sigma})\,m^{\sigma\mu}\,\partial_{\mu}\,\psi + k\psi = 0 \qquad (\lambda = \text{real constant}).$$

It is obvious that dual terms in $\gamma^{\rho}\gamma^{\sigma}\gamma^{\tau}$ and $\gamma^{1}\gamma^{2}\gamma^{3}\gamma^{4}$ could also be added without disturbing the invariance ; but as only the contribution of the $\gamma^{\mu}\gamma^{\nu}$ term brings something new, we shall leave them out at the present stage.

The particle defined by (1) has some remarkable properties close to those of Dirac's electron. It has a constant charge, and we may therefore call it a 'particle'. Its main feature is the spontaneous change of energy and momentum. The total amount of energy varies, even in the case of no field and even if the particle is 'at rest' and therefore has a vanishing kinetic energy. As the time passes, the particle loses or gains energy, even when resting, just like, for example, a living organism does. This change is connected with the existence of the new term in the equation and is proportional to the 'age' of the particle and to the constant $\lambda$. It can be computed from the expression of the symmetrical energy-momentum tensor[1] $T^{\mu\nu}$, which leads to :

$$\partial_{\nu}\,T^{\mu\nu} = 2\lambda\,(x^{\mu} - b^{\mu})\,(\partial_{\rho}\psi^{*}\,i\gamma^{4}\,m^{\sigma\rho}\;\partial_{\sigma}\psi),$$

giving thus a physical interpretation of the constant $\lambda$.

To define such a particle one must give, apart from its mass, a constant $\lambda$ *and* a point in space-time $b_{\mu}$, intrinsically defined as the (chosen) point around which the particle is almost conservative, behaving, in fact, like a classical Dirac electron. To achieve the definition of a particle by giving not only a mass and $\lambda$, but also a point in space-time, is most unfamiliar but by no means physically absurd. One can picture, for example, a conservative particle bound to some system and escaping from it at a given moment. If, when escaping from the nucleus (or in general when being created), the particle acquires the non-conservation character, the moment and place where this happens are indeed an essential feature of its definition.

The symmetry of $T^{\mu\nu}$ causes the total angular momentum at the fixed point $b_{\mu}$ to be constant.

$\lambda$ is not necessarily small, so that the supplementary term cannot be always considered as a small perturbation. In this case one gets interesting results by investigating what happens around a certain point $x^{k} = a^{k}$ at a definite instant $x^{4} = a^{4}$, that is by assuming that $a^{\mu} =$ const. The equation is then solved by a plane wave $\psi = A \exp i(p_{\mu}x^{\mu})$, where $p_{\mu}$ is proportional to the energy and momentum.

The classical relation $(W/c)^{2} = \vec{p}^{\,2} + w^{2}c^{2}$ between energy and momentum is no longer valid ; the new relation shows that, in the Newtonian approximation, the total energy is composed of the kinetic energy arising from the translation movement of the particle, plus a rotation energy, a fact which can be foreseen from the original form of the equation.

Unlike Dirac's case, the quantum mechanical treatment of this particle is essentially one which uses an indefinite metric in Hilbert space[2], as the normalization integral is

$$\int \psi^{*}\,[1 + \lambda\,(x_{k} - b_{k})\,\gamma^{k}]\,\psi\,d\tau.$$

The Hamiltonian form $\partial\psi/\partial t + iH\psi = 0$ is easily obtained and brings to light the discontinuity sphere $1 - \lambda^{2}\Sigma(x_{\varkappa} - b_{\varkappa})^{2} = 0$, which plays an important part in the discussion and gives a geometrical interpretation of the newly introduced constant $\lambda$.

The striking fact about the above equation is that it follows quite naturally from a straightforward application of restricted relativity to the problem of the electron. This does not mean that it necessarily fits the physical reality, but seems to point towards the fact that its study might be worth while.

I am indebted to Prof. P. A. M. Dirac for invaluable discussion.

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[1] Cf. *Portugaliæ Physica*, **1**, 159 (1943).
[2] Cf. Pauli, *Rev. Mod. Phys.*, **15**, 176 (1943).

## 'Coloured Anthers': a New Monofactorial Character in Wheat, *T. vulgare*, Host.

IN most bread wheats the anthers are yellow but in occasional lines they are a characteristic purplish-pink colour. During some experiments with hexaploid or *vulgare*-series wheats a cross was made between a yellow-anthered spelt wheat, *Triticum spelta*, L., and a coloured-anthered bread wheat, *T. vulgare*, Host. (*T. spelta* is simply a variety of *T. vulgare* with the '*spelta*' gene or gene block $K^s$ on one of the pairs of chromosomes of the A or B sets instead of the allelomorph $k$ for the round type of glume of *T. vulgare*). Of the $F_2$ plants examined at anthesis, 28 had coloured anthers (*CaCa* or *Caca*) and 13 had yellow (*caca*).

| Anthers | Observed (O) | Calculated (C) | O–C | (O–C)² | (O–C)²/C |
|---|---|---|---|---|---|
| Coloured | 28 | 30·75 | —2·75 | 7·56 | 0·246 |
| Yellow | 13 | 10·25 | 2·75 | 7·56 | 0·735 |
| Total | 41 | 41·00 | 0·00 | $\chi^2$ = 0·981 | |

With $\chi^2 = 0{\cdot}981$, for 1 degree of freedom, $P = 0{\cdot}5$–$0{\cdot}3$, showing a good agreement with a 3 : 1 ratio.

After harvest, of the 41 plants classified, for various reasons only 34 remained which could be classified with respect to the spelta/round glume characters. Classification was not easy as the parental bread wheat line is one which itself has a slightly keeled glume. However, the following results were obtained:

| Class | Observed (O) | Calculated (C) | O–C | (O–C)² | (O–C)²/C |
|---|---|---|---|---|---|
| Coloured keeled | 17 | 19·125 | —2·125 | 4·52 | 0·236 |
| Coloured round | 6 | 6·375 | —0·375 | 0·141 | 0·022 |
| Yellow keeled | 10 | 6·375 | 3·625 | 13·14 | 2·062 |
| Yellow round | 1 | 2·125 | —1·125 | 1·27 | 0·596 |
| Total | 34 | 34·00 | 0·000 | $\chi^2$ = 2·916 | |

With $\chi^2 = 2{\cdot}916$, for three degrees of freedom, $P = 0{\cdot}5$–$0{\cdot}3$, showing a good agreement with the assumption that the coloured/yellow anther alleles (*Ca/ca*) are monofactorial and independent of the keeled/round glume factors ($K^s/k$), giving a 9 : 3 : 3 : 1 ratio in the $F_2$.

The number of simply inherited characters in wheat is remarkably small, so that the present one, which does not appear to have been described before, may prove useful as a marker gene. That other types of coloured anthers may give 15 : 1 or 63 : 1 ratios is quite possible since multiple factors are common in wheat: the character described might well be only one of two or three such allelomorphs.

Classification is good but inconvenient unless the plants can be grown where they may be examined every day. At anthesis there is little difficulty in classifying a plant, though sometimes (in heterozygotes ?) the colour is pale or restricted to the base of the anthers. After shedding pollen, the anther seems to continue drying and become a dirty white colour indistinguishable from that of an old dehisced yellow anther. Thus classification must be done during anthesis. The temperature during development seems to be rather important—all the $F_1$ plants were grown in a greenhouse, and they, as well as plants from similar crosses and plants from the line of the coloured parent, all had yellow anthers. The $F_2$ was grown outside, and the cool summer of 1944 was favourable for the expression of the character in these plants and in the parental and similar lines.

Thus the character 'coloured anthers' offers a new allele which, at least in this case, is easily classifiable, is monofactorial and is independent of the keeled/round glume allelomorphs.

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## Shape of Sea-Urchins

IN the latest edition of "Growth and Form" (1942), Sir D'Arcy Thompson has directed attention to the analogy between the shapes of drops of such a liquid as *ortho*-toluidine when resting on the bottom of a vessel filled with water, and the shapes of sea-urchins. Thus a small drop remains practically spherical while a large drop spreads itself out, or more or less sags under its own weight (pp. 946–48).

In this way, Sir D'Arcy Thompson seeks to account for the pronounced flattening of some of the sea-urchins while he attributes the marked conical shape of others to the presence of masses of *fatty, oily eggs*, which have a density less than that of sea-water and thus raise the upper surface.

Some recent work carried out at Plymouth, however, would indicate that both these concepts require revision.

It is not denied that a sea-urchin with a very flexible shell might become flattened under its own weight, but flattening does not necessarily imply a non-resisting shell.

One of the sea-urchins recently studied was *Psammechinus miliaris* (Gmelin), which was found to have a density of 1·3457 at 14° C. and to contain 55·5 per cent water. The figures represent the mean of four determinations. One of the chief characteristics of this urchin is its marked flattening, its height seldom exceeding half the diameter. The urchin is, however, remarkably resistant to weight. This was proved by the very simple experiment of placing a specimen, after it had drained on filter-paper for a few seconds, under the right-hand pan of a 5 kilo Oertling balance. Weights equal to 4 kilos were placed on the left pan and two weights each of 2 kilos were placed on the right pan.

On removing the weights carefully from the left pan the right pan rested on the urchin, and it was found that the animal could support the whole 4 kilos without undergoing injury, and since the urchin in question only weighed 19 gm. it was thus supporting more than two hundred times its own weight.

The second concept, namely, that of the upper part of the shell being raised by the presence of ova lighter than sea-water, also requires moderation, for the ova of sea-urchins contain very little fat and at no period of their existence is their density less than that of sea-water. The whole concept of buoyancy by oil drops in sea-water requires revision, for though such oil drops are fairly common their density is usually about 0·9. Thus in marine invertebrates, if the density of calcite is 2·7 and that of silica 2·5, that of chitin 1·4 and of protoplasm itself 1·05, the presence of a small amount of oil or fat with a density of 0·9–0·8 can have very little buoyancy effect. It is very doubtful whether any appreciable buoyancy effect due to fats or oils is to be found except among

the mammals. The ova of *Acanthias vulgaris* contain practically 30 per cent fat, but the ova still retain a density of 1·055.

It is true that the flattening might take place during the very early stages of development of the sea-urchins, but at this stage there would scarcely be any pronounced ovaries; and again if these supposedly light ova could lift the upper shell of the urchin, would it not occur in one sex only and thus impress marked sexual dimorphism, which appears to be so markedly lacking among the echinoids?

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## A New Type of the *Salmonella* Genus

In a previous communication[1], as a matter of preliminary report, a few properties of *S. hormæchei* were described, the antigenic structure of which differed from those of all known types.

This *Salmonella* was isolated by means of Kauffmann's 'combined method' from the ovary of a hen the blood of which gave a positive reaction with the pullorum antigen coloured and dead.

*S. hormæchei* presents morphological, tinctorial and culture characters, which coincide, except for the slight variations described below, with the bacteria belonging to the *Salmonella* genus. It is mobile. It develops vigorously in the usual culture media. In agar, the culture is adherent. In liquid media, a noticeable turbidity can be observed, which later becomes intense, the sediment is abundant and does not easily disintegrate by agitation. It shows in the liquid mass, as well as in contact with the inner wall of the container, a fine granulation. The formation of a slight superficial veil can be noticed.

It ferments, with the production of acid and gases, dextrose, arabinose, dulcitol, galactose, rhamnose, lævulose, maltose, manitol, manose, sorbitol, trehalose and xylose. It does not attack starch, erithrite, inosite, inulin, lactose, raffinose, saccharose or salicine. It does not produce indol. It does not coagulate milk. It does not produce hydrogen sulphide. It does not liquefy gelatine. It gives a positive reaction with Stern's test; Bitter, Weigmann and Habs media, positive, with dextrose and arabinose; subpositive, with dulcitol and rhamnose; Simmons media, with arabinose, dextrose, dulcitol, rhamnose and citrate, all positive. Positive reaction opposite to *d*-tartrate, mucate, *l*-tartrate, *i*-tartrate and citrate. Reduces nitrates to nitrites; does not hydrolyse urea.

The antigenic structure, which has been studied by means of the 'mirror test', indicates that *S. hormæchei* possess the same antigenic '*O*' thermostable of *S. ballerup*; but on the other hand it has not been possible, at least thus far, to find antigen *Vi*.

The flagellar antigens present special interest, since they are considered to be an antigenic 'mosaic', constituted by two fractions not referred to hitherto, where one of them corresponds to '*H*' antigen specific, which we designate by the symbol $Z^{30}$, and the other is common with *S. ballerup*; we distinguish it by the symbol $Z^{31}$. Concerning the latter, researches are being continued. The abbreviated serological formula of *S. hormæchei* is represented in the following form, XXIX.$Z^{30}$.($Z^{31}$).—., where $Z^{31}$ is in brackets in order to show that in certain circumstances it may be lacking. Inoculations in mice, guinea pig and rabbits, by the oral, subcutaneous and intraperitoneal routes, have not caused death in any case.

*S. hormæchei* corresponds to the second new type of *Salmonella*, isolated and classified in Argentina by me, the first having been *S. bonariensis*.

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[1] Monteverde, J. J., *Nature*, **149**, 472 (1942).

## Collapse of Determinism

Now that this subject has been raised again in these columns[1] I should like to ask a question which puzzles the 'everyday' physicist who is paid to keep his feet on the ground.

In his Guthrie Lecture, Prof. Whittaker, after discussing hidden parameters in relation to the reflexion or transmission of light, says: "Thus the choice between the alternatives of transmission and reflexion at the Nicol is truly indeterminate, so far as individual photons are concerned, and is qualified only by a statistical regularity when great numbers of events are considered" (that is, $\cos^2 \varphi$ of the intensity is transmitted and $\sin^2 \varphi$ reflected).

My difficulty is that if the final result of, say, one million, or billion, photons is regular (that is, determined), then how can the choice of any (except the first few) be individually indeterminate? Surely there must be some influence set up by the first 999,000 photons which will bias the indeterminate motion of the last 1,000 in order to balance the statistical result if the first arrivals have been a little too free with their indeterminacy. The introduction of a certain experimental error in measurement of the intensity does not affect the argument.

The difficulty is so obvious that I feel one has the right to demand a *simple* explanation to clear it up. It is independent of any particular knowledge of photons or of the mathematics of indeterminacy.

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[1] *Nature*, **154**, 464 (1944).

FOR a profound study of the question of determinism in physics, reference may be made to Prof. J. von Neumann's "Mathematische Grundlagen der Quantenmechanik", p. 157 *et seq.* I doubt if any very simple treatment can be quite rigorous; but in connexion with Mr. Barkas's point, the following line of thought might be profitable. If a coin is tossed a thousand times and the number of occurrences of heads recorded, and if this experiment is repeated a very great number of times, there will be a statistical regularity in the records, which may be calculated by the ordinary theory of probability. Does the calculation at any stage involve the assumption that the tossing of coins is crypto-deterministic, or does it involve only the assumption (as regards the tossing) that there is symmetry in the system, so that there is no reason to expect heads rather than tails in a single trial?

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# PENICILLIN TREATMENT

A SPECIAL issue of the *British Journal of Surgery* (**32**, 105–224, 1944. 12*s*. 6*d*. net) is devoted to reports by British and United States medical men on the treatment with penicillin of battle casualties which has been carried out during the present War. Everybody who is at all interested in penicillin should read this valuable and beautifully produced record. It is only two years, Major-General L. T. Poole explains in his foreword, since Sir Howard Florey offered to the British War Office a small quantity of penicillin for trial in the Middle East. This was successfully flown out there, in spite of the difficulties of communications at that time. The strength of the first batches received by the Army varied from 30 to 40 Oxford units per mgm. Nowadays some of the preparations used have a strength of about 1,600 units per mgm. This is one measure of the progress made in this short period. The progress in production may be gauged by the fact that the Penicillin Team sent to North Africa in May 1943 was equipped with ten million units, whereas later it was possible to send by air regularly to Italy twenty million units a day.

Penicillin treatment is not, of course, to be lightly undertaken. Everywhere in this record of its use the necessity for the training of teams of workers for its application is emphasized. Sir Howard Florey and M. A. Jennings deal with the general principles of the treatment. They summarize the properties of penicillin, which Sir Howard Florey has already described in *Nature* (Jan. 8, p. 40, 1944). Modern methods of its administration are less well known and are here described by Sir Howard and M. A. Jennings and by other contributors. The rapid absorption and elimination of penicillin must always be borne in mind. Relatively large doses must be given and these must be frequently repeated. A continuous concentration of the drug must be maintained in contact with all the infected tissues. For systemic administration penicillin is usually given by intramuscular or subcutaneous injection. After intramuscular injection the maximum concentration in the blood is reached after fifteen minutes, so that little is gained by intravenous administration. Absorption from subcutaneous injection is somewhat slower. Excretion in the urine begins as soon as the penicillin reaches the blood. As a rule, in the fourth hour after a dose of 15,000 units, a bacteriostatic concentration no longer exists in the blood, so that the dose should be repeated every three hours. Excretion is so rapid that there is probably no advantage in increasing the dose of 15,000 units originally established by the Floreys as the generally effective dose. The same total dose can be given by a continuous intravenous or intramuscular drip or by continuous subcutaneous infusion. For local administration, penicillin in the form of a powder, a solution or in creams can be used. Brigadier R. W. Mackenna (*The Lancet*, 314, Sept. 2, 1944) has devised a dosimetric spray for the treatment of skin diseases.

Because penicillin must be brought into contact with every part of the infected tissues, all dead tissue must be removed. Penicillin is not, therefore, a substitute for surgery, and most of the surgeons contributing to this symposium emphasize this fact. For the same reason too much should not be expected from it when certain kinds of severe injury are being treated. Major R. Furlong and Major J. M. P. Clark, for example, reporting on the treatment of open fractures of the femur, conclude that the penicillin treatment given by them did not control sepsis fully; but this kind of battle casualty presents the surgeon with great difficulties. It may, for example, be difficult to obtain adequate drainage of all parts of such extensive and complex injuries as these, and, as the authors remark, "penicillin cannot be expected to clean Augean stables". Lieut.-Colonel Jeffrey, who succeeded Lieut.-Colonel Ian Fraser as penicillin surgical officer in North Africa and Italy when the latter was invalided home, reports, however, in his article on battle fractures in Italy, that penicillin, in his experience, very largely controlled the infection. Without the assurance that this would be so, the necessary radical surgical treatment would not have been justified in such cases as compound fractures more than twelve hours old. The authors of both these articles on battle fractures record a reduction of mortality and fewer losses of limbs as the result of the use of penicillin.

The hastening of healing by early closure of the wound and the instillation of penicillin through fine rubber tubes placed in the wound is discussed by Lieut.-Colonels F. H. Bentley and J. J. Mason Brown. Photographs illustrate the method of doing this. Penicillin may also be injected with a needle. Like some other substances, penicillin passes only slowly from the blood into the cerebro-spinal spaces, and into the pleural and probably the joint cavities also. For meningitis, Sir Howard Florey and M. A. Jennings state that intrathecal injection by the lumbar route or into the lateral ventricles of the brain is most effective. Fleming and others have shown that this method maintains a bacteriostatic concentration in the cerebro-spinal fluid. The article by Brigadier Hugh Cairns deals with this method for the treatment of wounds of the head and spine, to which penicillin can be applied either as a powder, as a solution instilled through rubber tubes in the wound, by systemic routes or by injection of it by the lumbar route or into the lateral ventricles of the brain. Sulphadiazine or sulphamezathine are, he says, useful additional means for the prevention or prophylaxis of meningitis. One is reminded here of the claims made by some Russian workers that tetanus can be successfully treated by a similar injection of tetanus antitoxin into the lateral ventricles of the brain and the cerebrospinal spaces, the so-called blood-brain barrier being thus overcome. Brigadier Cairns, like his colleagues, emphasizes the need for "careful surgical toilet" in addition to the penicillin. Two articles describe the use of penicillin for treatment of wounds of the chest, and the value of penicillin is agreed, although its value for cases of hæmothorax is less certain.

The two articles on the treatment of gas gangrene indicate that more work is required on the treatment of this condition with penicillin. In one of these articles, which is illustrated by photographs in colour of the progress of battle wounds, Col. Elliott C. Cutler and Major W. R. Sandusky, United States Army, record that penicillin did not prevent the development of gas gangrene in seven cases treated locally and parenterally. This number of cases is, they conclude, too small to enable them to assess the real influence of penicillin on gas gangrene, but they think that surgical treatment is the main factor in the prophylaxis and treatment. Lieut.-Colonel J. S. Jeffrey and Major Scott Thomson report on thirty-three cases of gas gangrene in Italy and conclude

that penicillin was definitely useful. The causative organism in Italy was *Cl. welchii*.

The use of penicillin for the treatment of venereal disease is described in two articles. Major J. N. Robinson, United States Army, concludes that "penicillin is the most effective agent we have for treating all types of gonorrhœa. If the supply were unlimited, it would be the therapy of choice". Lieut.-Colonel D. M. Pillsbury and Major C. S. Wise, United States Army, report their confirmation of earlier work which showed that penicillin rapidly kills the spirochætes which cause syphilis and causes early regression of syphilitic symptoms; the immediate effects of penicillin are, they think, better than those of the arsenical preparations. The bibliography, which contains, the editors say, references to all the previous published work on penicillin, refers to work on other spirochætal infections, such as relapsing fever.

The low toxicity of penicillin, especially of the purer forms of it now available, is one of its most remarkable features. It is almost certain, say Sir Howard Florey and M. A. Jennings, that such clinical reactions as are seen in some cases are due to the impurities which are present in all preparations of penicillin. There is all the more reason for the warnings which have been issued against the use of 'home-made penicillin' and preparations of other fungi. One of the outstanding features of this symposium is, indeed, the insistence in more than one article of the need for careful technique, which should be carried out by specially trained teams, and for the control of the treatment by the bacteriologist. Penicillin has, moreover, certain definite limitations which are indicated by Sir Howard Florey and M. A. Jennings and by Lieut.-Colonel J. S. Jeffrey. Certain organisms are resistant to it, nor can penicillin act on organisms susceptible to it when these are in dead tissue or in the centre of abscesses or masses of pus; it cannot affect bacterial toxins either. Ignorance or neglect of these facts, inadequate dosage and lack of proper supervision of the technique may result in disappointment. There has, however, been little tendency to neglect adequate surgery or to rely too much upon penicillin. The bacteriological control necessary is well described by Prof. L. P. Garrod and N. G. Heatley in their account of the diagnosis of bacteria in wounds, of the standardization of the Oxford unit (the unit of potency) and the methods of assay of penicillin used for treatment or present in exudates or in the blood or other body fluids.

Major Scott Thomson describes the bacteriological examination of wounds treated with penicillin. "Exacting to handle and unstable though it may be," say Sir Howard Florey and M. A. Jennings, penicillin should not fail if it is given continuous contact with the tissues involved. This is the surgeon's problem and often it is not an easy one. The three main uses of penicillin, Lieut.-Colonel J. S. Jeffrey concludes, are to prevent infection soon after the infliction of the wound (in the forward areas), to control it during the first two weeks (at the forward base hospitals) and to combat infection in the later stages. The routine use of penicillin, he says, saves lives and minimizes functional disability and loss of man-power; it allows more rapid healing than has been possible before. It may therefore be especially useful, as Major-General L. T. Poole points out, to airborne troops, who may have to wait some time before the main forces fighting towards them can evacuate their wounded.

Future work, says Major-General Poole, will seek corroboration of the results already obtained and will tackle the problems which this work has raised. For this the continuation of the existing collaboration of chemists, pathologists, bacteriologists, clinicians and surgeons will be required. The collaboration here recorded between British and United States workers reminds us of the debt we also owe to others in the United States who have helped British workers to produce penicillin in such quantities that we can all now share its benefits. In Great Britain this debt is freely acknowledged. It is but one more instance of that co-operation of the English-speaking peoples which has done so much all over the world for the control of all kinds of human disease.

Since the above was written, a number of articles on penicillin have appeared which are related to several of the points mentioned.

*The Lancet* (348, Sept. 9, 1944), in a valuable annotation on penicillin, discusses the production of penicillin and the regulations which now control the manufacture of penicillin crude filtrate, dried crude filtrate and purified penicillin in the form of its sodium salt, and the good results which have been obtained with crude filtrates. The new regulations do not prevent any hospital from preparing penicillin for its own use. *The Lancet* refers to the full account of the preparation and properties of crude penicillin given by A. M. Fisher (*Bull. Johns Hopkins Hosp.*, **73**, 343; 1943). In the same issue (page 336), I. W. J. McAdam, J. P. Duguid and S. W. Challinor describe the types of apparatus for continuous or three-hourly administration of penicillin. G. V. Osborne (*The Lancet*, 407, Sept. 23, 1944) describes an apparatus for administration by continuous ultra-muscular drip. Dr. C. A. St. Hill (*Brit. Med. J.*, 631, Nov. 11, 1944) describes an apparatus, easily made from routine pathological equipment, for subcutaneous or intramuscular administration of penicillin to infants and young children.

The 'mega unit' of penicillin, which represents a million Oxford units, is discussed in *The Lancet* (522, Oct. 21, 1944); it is used only for ordering supplies in order to obviate the necessity of writing out hundreds of thousands of Oxford units and confusion with the American billion, which is only a thousand million. The international uniform standard and unit of penicillin agreed upon at the recent conference of the Health Section of the League of Nations are described in the *British Medical Journal* (572, Oct. 28, 1944, and *The Lancet*, 574, Oct. 28, 1944).

Lieut.-Colonel J. W. Bigger (*The Lancet*, 497, Oct. 14, 1944; see also p. 508) has described a method of alternately giving and withholding penicillin for infections with *Staphylococcus pyogenes*, based on his view that penicillin acts on bacteria at the time of their division and also actually kills staphylococci. A. M. Fisher (*loc. cit.*; see also *The Lancet*, 348, Sept. 9, 1944) found that it is bactericidal to *S. aureus*. Lieut.-Colonel Bigger believes that the few staphylococci which survive the penicillin do so because they are in a non-dividing phase. He calls them 'persisters', and his method aims at killing them when the penicillin treatment is recommenced.

W. McKissock, V. Logue and I. Bartholomew (*Brit. Med. J.*, 551, Oct. 28, 1944), reporting on the local penicillin treatment of battle wounds of the head, emphasize the need for asepsis.

In view of the desirability of finding some method of slowing down the rapid excretion of penicillin, the work done by K. H. Beyer and his colleagues (*Science*,

100, 107; 1944; see *The Lancet*, 542, Oct. 21, 1944), which indicates that intravenous administration of *p*-amino-hippuric acid delays the renal excretion of penicillin, merits further trial.

Lieut.-Colonel Bigger (*The Lancet*, 400, Sept. 23, 1944) claims that penicillin is, contrary to the statement made about it by many writers, inactivated by human blood or serum. The degree of inactivation varies, however, considerably with different specimens of serum and is much greater at body temperature than at lower temperatures. It may lead the bacteriologist to under-estimate the amount of penicillin in the serum of a patient, particularly when the concentration is low. Inactivation *in vivo* is probably chiefly important in cases in which the excretion by the kidneys is slow. The author, discussing the fact that penicillin is excreted chiefly by the kidneys, refers to Sir. Howard Florey's comparison of the struggle to maintain an adequate concentration of penicillin in the blood to efforts to fill a bath while the plug is out. If, Colonel Bigger says, penicillin is constantly being inactivated by the plasma, we should add to this comparison a running cold tap and, in view of the difficulties of supply, a boilerman highly conscious of the need for fuel economy. The author also discusses the work of C. H. Rammelkamp and S. E. Bradley (*Proc. Soc. Exp. Biol. and Med.*, **53**, 30; 1943), who found that the administration of 'Diodrast' (B.P. diodone) delays the excretion of penicillin.

Marie Kalisova (*Brit. Med. J.*, 597, Nov. 4, 1944) describes "the dramatic effect of penicillin on what would otherwise have been a hopeless case of acute appendicitis" in a child aged four. The penicillin was introduced directly into the peritoneal cavity, and by repeated aspirations of exudate from this cavity and its replacement by penicillin the patient's condition improved and his life was saved.

G. LAPAGE.

## ANTISEPTICS

THE first Lister Memorial Lecture of the Society of Chemical Industry was delivered on November 9 by Sir Alexander Fleming, of St. Mary's Hospital, London, at the University of Edinburgh; the title of Sir Alexander's address was "Antiseptics".

Lord Lister, in his epoch-making work, used carbolic acid as an antiseptic in surgery. This had the advantage of attacking all microbes equally, but the disadvantage of being poisonous to man and of destroying the leucocytes or white corpuscles of the blood which themselves act as the chief weapon in the body's own antiseptic armoury. The latest antiseptics, on the contrary, have a much greater effect against certain bacteria but are less destructive to leucocytes; the antibacterial to antileucocytic ratio of penicillin is 250,000, of sulphanilamide 1,000, but of carbolic acid only ½.

Sir Alexander Fleming described his discovery of penicillin in 1929. There had been nothing in the literature to make anyone suspect that a substance with the chemical constitution of penicillin would have antibacterial value. The discovery had to come by chance, and it was his good fortune that the chance had presented itself to him. While working on quite a different subject he noticed that a mould (later proved to be *Penicillium notatum*), growing as a contamination on a culture plate, made a noteworthy change in colonies of staphylococci on the plate. Thanks to his long interest in antiseptics and to his previous discovery of the natural antiseptic, lysozyme, Sir Alexander kept the plate for examination instead of throwing it away as many bacteriologists must have done before. The lapse of ten years between his discovery of penicillin and its preparation in a concentrated form suitable for therapeutic trial by the Oxford workers was due to the difficulty of concentrating and purifying it. This was a chemical problem. He himself was a bacteriologist.

It is calculated that pure penicillin, even if diluted to 1 in 50 million or more, will inhibit the growth of staphylococci, the common microbe of boils and carbuncles. On the other hand, it is so non-poisonous that, so far as Sir Alexander is aware, no one has yet had enough to poison a man. Like the sulphonamides, it is very specific, affecting certain microbes but having little or no action on others. It seems unlikely that we shall ever get an antiseptic which will affect all microbes without being poisonous to some human cells, but we shall have to arm ourselves with a series of chemicals covering the whole range of microbic growth. This will make it more difficult for the medical man; he will have to pay more attention to bacteriology than heretofore.

Penicillin is not perfect. For one thing, it is so rapidly destroyed in the stomach that it cannot be given by the mouth. There is still scope for the chemist to synthesize it, and then tinker with the molecule so that the imperfections can be remedied. There are thousands of other micro-organisms which may be capable of manufacturing even better antiseptics than penicillin, or ones which might give a clue to the chemical linkages responsible for the destruction of bacteria. The work is not finished—it is just beginning—and it is for the chemists now to carry it further.

## THE SCOTS PINE (*Pinus sylvestris*)

By ALEXANDER L. HOWARD

I remember, I remember,
The Fir-tree dark and high.
I used to think their slender tops
Were close against the sky.

THOMAS HOOD.

THIS tree, which is often incorrectly called 'fir' or 'Scotch fir', is a native of Britain, and the most important of our coniferous trees. From earliest days magnificent pine forests have grown in the Scottish Highlands where, as the Rev. C. A. Johns says, the seeds have been carried far and wide by the violent winds which are prevalent in that country, and also by rooks who are "Nature's planters of Pine Woods".

Gerard (1545–1612) speaks of these trees as

"growing in Cheshire, Staffordshire, and Lancashire where they grow in great plentie, as is reported before Noah's floud, but then being overflowed and overwhelmed, have been since in the mosses and waterie moorish grounds, very sound and fresh until this day; and so full of resinous substance that they burn like a torch or linke, and the inhabitants of those countries do call it Firre Wood and Fire woode unto this day."

Some people consider the Scots pine an uninteresting tree, and it is true that when reared under modern conditions in regular rows the conventional habit of its growth is apt to destroy its decorative value.

When planted with other trees it stands out conspicuously; but probably to appreciate its beauty to the full it should be seen as so many famous artists loved to paint it, in a group standing on high ground, thus outlined against the sky.

Under good conditions the Scots pine grows with great rapidity, reaching a height of about 100 ft., a clean bole of 70–80 ft., with a girth of 10–11 ft.

The bark is tough and fissured; the lower part of a dark reddish-brown, and the upper smoother and bright red. In early life the thick bushy foliage grows in pyramidal form flattening out later into tiers of irregular shape.

Johns tells us that in the Highlands of Scotland

"almost every district bears the trace of the vast forest with which at no very distant period, the hills and heaths were covered . . . on the South of Ben Nevis a large Pine forest . . . was burned to expel the wolves."

One wonders whether Robert Bridges had made a study of scientific forestry when he wrote:

"His spear, to equal which the tallest pine hewn on Norwegian hills . . . were but a wand."

However that may be, it is a fact that in Norway, Sweden, Finland and Russia the Scots pine has played the most important part in the economic history of these countries; especially in Russia has the subject received intense study, and been given every scientific assistance, but unfortunately the same cannot be said of Great Britain, with the exception of some effort since the establishment of the Forestry Commission.

It is not surprising, therefore, that the quality of British-grown pine has been found generally very inferior to that imported from these other countries. Whereas in the U.S.S.R. an excellent system of grading has been adopted, in most other places either little attention has been paid to the question, or conditions do not allow of much variation, for the general quality of the timber is fairly uniform, and up to now could not be classed in a high grade. The variation in England, however, is considerable, some districts producing excellent timber while others only poor quality.

Lord Sackville told me that one of his ancestors three hundred years ago brought from Memel Scots pine planks to provide floors for the long galleries at Knowle Park, Sevenoaks, as the trees growing on his own land, though abundant, were of poor quality.

In the time of Samuel Pepys, Scots pine was only imported in one dimension—three inches by nine inches and 12 ft. in length. These were termed 'deals' in England; other sizes were termed 'planks', 'battens' and 'scantlings'. Curiously enough, whereas the other terms were never adopted except for their real meaning, the word 'deal' became known to describe any kind of coniferous wood regardless of size, the name being still used wherever English is spoken.

Samuel Pepys, under date of October 18, 1664, records in his Diary:

"Thence to the Exchange, and so home to dinner, and then to my office, where a full board, and busy all the afternoon, and among other things made a great contract with Sir W. Warren for 40,000 deals Swinsound, at £3.17/– per hundred."

One hundred deals of similar character would cost to-day £69 17*s*. Swinsound was a port of Norway, about a mile from Fredrikshald, close to Frederikstadt, and now called Halden. The deals were hand-sawn and of superior quality. Norwegian imports, under the name of 'Christiania', continued, and the name 'Christiania deals' was still in use up to 1939. Probably the last shipment into England was in 1878, after which Norwegian supplies failed. From this time forward importations from Sweden, Finland and Russia increased in volume year by year; later supplies were received from Canada, America, southern Europe and Poland. All these revealed an ever-growing destruction of the larger trees. For several years after 1878 shipments consisted of more than 75 per cent of sizes 3 in. by 9 in. and larger, with only 25 per cent of smaller dimensions, but by the year 1939, except for the U.S.S.R., only 15–20 per cent could be obtained of the larger sizes. While with the Russian a better average of large sizes was maintained, not more than one piece in five was free of the centre, whereas in earlier years only one centre piece would be found with four or five quite free. Throughout, the inclusion of sap wood has greatly increased, and scantling sizes are almost all sap wood. The foregoing is a clear indication of the manner in which the forests are being exhausted.

In 1937–38 we expended the immense sum of £51 million on importations from Sweden, Norway, Finland, the U.S.S.R., Esthonia, Latvia, Lithuania, Poland, Yugoslavia and Rumania, the principal of which was Scots pine. This was used for joists, beams, rafters, flooring, etc., and the better qualities for joinery work, doors, window-frames, shelves and cupboards, etc. Prior to this War (1939) trees grown in Great Britain were used only for rough work such as gates and fences, and for estate purposes, but lately so great has been the demand that what was once considered inferior is now regarded of great value. Bearing in mind the vast building operations which will be necessary for many years after the War, Scots pine will be more than ever in demand, and should be planted freely in all suitable areas where the climate and soil are congenial, and reared on the most scientific principles of forestry, in order that the quality may be improved.

## PRINCIPLE AND PRACTICE IN VEGETATIVE PROPAGATION

PRACTICES of vegetative propagation of plants, originated in antiquity, and used without change for many centuries, have probably received a greater inspiration from modern science than any other of man's ancient occupations. The discovery of plant hormones made it possible to propagate species which had previously defied the greatest horticultural skill. There are, however, many other factors which have recently been passed in masterly review by R. J. Garner*.

Although the title of the pamphlet places special emphasis on pome and stone fruits, the work includes consideration of a wide variety of plant species, and certain generalizations are possible. New growth is a better source of cuttings than older material, and the presence of abundant stored carbohydrate food also assists this form of propagation. Indeed, soaking cuttings in sugar solution has often induced rooting. Lateral shoots are superior to terminals, and basal

* Imp. Bur. of Hort. and Plantation Crops. (Tech. Comm. No. 14.) Pp. 1–79. (I.A.B. Central Sales Branch, Agricultural Research Building, Penglais, Aberystwyth, Jan. 1944.) 3*s*. 6*d*. net.

cuttings root best. "The time of taking cuttings should be governed by the condition of the material rather than by the calendar." Various methods of application of synthetic hormone substances are described and, although these still give varying results, they represent by far the greatest single advance in technique. The effects of temperature, moisture and light form an interrelated complex, which should be determined for each species. Wound stimulation can increase rooting response; leaves are generally necessary, but flowers are a hindrance to regeneration.

Rooting media must be well aerated, but must also hold sufficient moisture; peat is considered to provide rooting stimulants, possibly of hormone nature. Some stem cuttings root better after an initial period of inversion, while some root cuttings regenerate better if the proximal end is above the compost. The presence of nitrogen hinders the rooting of normal plants, but nitrogen-starved growth may occasionally be stimulated to root by treatment with suitable nutrient solutions. Layering and marcotting (aerial layering) appear to depend for their full success upon some form of constriction or ringing which presumably increases the carbohydrate in the parts which are to root. Mr. Garner finally discusses the application of principles revealed by his survey to the practices of propagating fruit trees in use at the East Malling Research Station. Many orchards and nurseries are at present in bad condition because of the War, and Mr. Garner's publication has the objective aim of demonstrating the best methods for their restoration when peace returns.

## GROWTH OF CEREAL EMBRYOS

SINCE the pericarp in a cereal such as barley is semi-permeable, during the first period of germination the embryo is exposed to a low level of water and oxygen availability (0·1 atm.) and a relatively high carbon dioxide concentration (0·1 atm.) (R. Brown, *Ann. Bot.*, N.S., 93 and 275; 1943). In contrast, when excised embryos are being cultured, as in attempts to elucidate some of the problems of vernalization and kindred phenomena, the young plants are being started under conditions of high water and oxygen availability. Whether grown on water or culture solutions, such isolated embryos always show an immediate drop in dry weight, followed by a slower loss over at least the first twelve hours, suggesting a leaching effect followed by a rather higher rate of respiration than in the embryos of intact grains.

The change-over from a dormant embryo with dense non-vacuolate cells to a seedling in a fully active state seems to occupy about the first seventy-two hours, since after that time the water content remains constant. Although the food reserves in the endosperm are not available to the young plant during the first twenty-four hours of germination, excision within the first twelve hours of germination affects the linear and dry-weight growth, suggesting either that some substance is being absorbed (a hormone ?) or that the internal carbon dioxide concentration has a stimulating effect, either directly or by altering the acidity of the environment. When the carbon dioxide concentration is high, as in an intact grain, a low level of water-availability stimulates the linear and dry-weight growth of the embryo, either when attached or when growing on a nutritive medium. On the other hand, linear and dry-weight growth do not appear to be influenced by changes in oxygen concentration provided it is above about 15 per cent.

"Each of the factors considered above tends to be at a level inside the seed which, relative to the incident level of the same factor outside the seed, stimulates the subsequent growth of the seedling"; and there is probably "a high degree of instability in the metabolic pattern of the embryo . . . subject to modification according to the nature of the environment in which early development occurs".

## FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

### Saturday, November 25

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (joint meeting with the SCIENTIFIC AND TECHNICAL GROUP OF THE ROYAL PHOTOGRAPHIC SOCIETY) (at 16 Princes Gate, South Kensington, London, S.W.7), at 3 p.m.—Mr. G. Parr: "The Electron Microscope"; Dr. E. M. Crook, Miss F. M. L. Sheffield and Mr. L. V. Chilton: "Photographic Materials for use in the Electron Microscope"; Dr. D. G. Drummond: "Electron Micrography of Textiles".

### Monday, November 27

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. S. J. Folley: "Milk", (2) "The Hormonal Control of Lactation" (Cantor Lecture).

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S.W.7), at 5 p.m.—Mr. C. Hope Gill: "The Hadhramaut" (Kodachrome Film).

BRITISH INSTITUTION OF RADIO ENGINEERS (LONDON SECTION) (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6 p.m.—Mr. E. R. Friedlander: "Magnetic Dust Cores".

INSTITUTION OF ELECTRICAL ENGINEERS (LONDON STUDENTS' SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. W. A. Hatch: "Some Hydro-Electric Possibilities and Achievements".

IRON AND STEEL INSTITUTE (joint meeting with the SHEFFIELD BRANCH OF THE INSTITUTE OF BRITISH FOUNDRYMEN) (at the Royal Victoria Hotel, Sheffield), at 7 p.m.—Mr. B. Gray: "The Side Feeding of Steel Castings—a Note on the Influence of the Mechanism of Freezing".

### Tuesday, November 28

BRITISH PSYCHOLOGICAL SOCIETY (INDUSTRIAL SECTION) (at the National Institute of Industrial Psychology, Aldwych House, Aldwych, London, W.C.2), at 12.45 p.m.—Prof. E. A. Bott: "Some Problems of Selection and Training in War and in Peace" (followed by Questions and Discussion).

ROYAL ANTHROPOLOGICAL INSTITUTE (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 1.30 p.m.—Prof. V. Gordon Childe: "Archæological Ages as Technological Stages" (Huxley Memorial Lecture).

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2 p.m.—Mr. C. Culpin: "Machinery for Crop Cultivation".

CHADWICK LECTURE (at the Sir Edward Meyerstein Lecture Theatre, Westminster Hospital Medical School, 17 Horseferry Road, Westminster, London, S.W.1), at 2.30 p.m.—Mr. J. A. H. Brincker: "Research in all its Various Aspects Essential for the Promotion of Health and the Prevention of Disease" (Malcolm Morris Memorial Lecture).*

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 5.15 p.m.—Mr. F. C. Bawden: "Plant Viruses and Virus Diseases", (ii) "The Properties of Purified Plant Viruses".

ROYAL STATISTICAL SOCIETY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Sir William Elderton: "Cricket Scores and Some Skew Correlation Distributions (An Arithmetical Study)"; Mr. George H. Wood: "Cricket Scores and Geometrical Progression".

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 5.30 p.m.—Reception to the Visiting Indian Scientists, when addresses will be given by Sir Shanti S. Bhatnagar, F.R.S., and Prof. J. N. Mukherjee.

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. A. Shaw Maclaren: "The Design of Land Airports for Medium and Long Distance Civil Air Transport".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Mr. E. Leslie Champness: "University Education in Shipbuilding and Naval Architecture".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1), at 6.30 p.m.—Mr. H. O. Howson: "The Formation of Banded Structures in Centrifugal Casting".

### Wednesday, November 29

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Brigadier L. E. H. Whitby: "The Army Blood Transfusion Service".

BRITISH INSTITUTION OF RADIO ENGINEERS (MIDLANDS SECTION), (in the Latin Theatre, The University, Edmund Street, Birmingham), at 6 p.m.—Mr. G. F. Knewstub: "The Super-regenerative Detector"

INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1), at 6 p.m.—Mr. M. Riddihough: "Hardsurfacing by Welding".

OIL AND COLOUR CHEMISTS' ASSOCIATION (at the Grand Hotel, Manchester), at 7 p.m.—Mr. G. A. Campbell and Dr. T. F. West: "DDT, the New Insecticide—a General Survey and some possible Paint Applications".

### Thursday, November 30

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 2.30 p.m.—Prof. James Gray, F.R.S.: "Locomotory Mechanisms in Vertebrate Animals", (ii) "Transition from Water to Land—Origin of the Limb with Five Digits, Its Development for Propulsion and Support".

INSTITUTION OF ELECTRICAL ENGINEERS (INSTALLATIONS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on (a) The Installation Section of the Report on "Electricity Supply, Distribution and Installation", and (b) The Report of the Electrical Installations Committee convened by the Institution on behalf of the Ministry of Works (to be opened by Mr. W. N. C. Clinch).

### Friday, December 1

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 6 p.m.—Prof. Herbert Dingle: "Spectrum Analysis".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. W. S. Graff-Baker: "Mechanical Engineering Problems of London Transport".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. G. C. McVittie: "The Spiral Nebulæ" (Lectures for the Forces, 1).

### Saturday, December 2

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES' BRANCH) (at the Royal Institution, Albemarle Street, London, W.1), at 2 p.m.—Conference on "The Selection and Training of Personnel for Industry" (to be opened by Major F. A. Freeth, F.R.S.).

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. G. M. Lees: "The Geology of the Oilfields of the Middle East".

SHEFFIELD METALLURGICAL ASSOCIATION (joint meeting with the IRON AND STEEL INSTITUTE and the SHEFFIELD SOCIETY OF ENGINEERS AND METALLURGISTS) (at the Royal Victoria Station Hotel, Sheffield), at 2.30 p.m.—Discussion of Papers presented to the Iron and Steel Institute.

## APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

VISITING PROFESSOR OF PHYSICS and VISITING PROFESSOR OF ORGANIC CHEMISTRY in the Farouk I University, Alexandria—The First Secretary, Royal Egyptian Embassy, 75 South Audley Street, London, W.1 (November 30).

ASSISTANT LECTURER IN ELECTRICAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (November 30).

LECTURER (full-time) IN MECHANICAL ENGINEERING—The Principal, Battersea Polytechnic, Battersea, London, S.W.11 (November 30).

LECTURER (man or woman) IN MATHEMATICS—The Registrar, University College, Southampton (December 1).

LECTURER (full-time) IN MATHEMATICS in the Science Department—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex (December 4).

MECHANICAL ENGINEERS for the Government of Nigeria Public Works Department—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. C.K.2361.A) (December 5).

LOCATION ENGINEER by the Government of the Tanganyika Territory—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. E.1209.A) (December 5).

ENGINEERS (temporary staff) by the Government of Nigeria for the Public Works Department—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. E.1212A.) (December 5).

PHYSICISTS AND RADIO ENGINEERS for Hertfordshire Laboratory of large group of Companies engaged on Radio Telecommunications Research and Development Work—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. A.631.XA) (December 5).

PSYCHOLOGIST AND EDUCATIONAL ADVISER (man or woman)—The Secretary, County Buildings, Shrewsbury (December 6).

RESEARCH BIOCHEMIST in the Department of Pathology in association with the Sheffield Radium Centre—The Registrar, The University, Sheffield (December 8).

ASSISTANT CHIEF ENGINEER in the Chief Engineer's Department—The Clerk of the London County Council, The County Hall, Westminster Bridge, London, S.E.1 (December 9).

LECTURER (full-time) IN MATHEMATICS in the Medway Technical College, Gillingham—The District Education Office, Kent Education Committee, Fort Pitt House, Rochester (December 9).

LECTURER IN AGRICULTURAL ECONOMICS—The Acting Registrar, The University, Leeds (December 9).

SPEECH THERAPISTS (two) in the Hertfordshire School Medical Services—The County Medical Officer, County Hall, Hertford (December 11).

ENGINEER AND MANAGER of the Plymouth Water Undertaking—The Town Clerk, Pounds House, Peverell, Plymouth (endorsed 'Water Engineer') (December 12).

ELECTRO-PLATING CHEMIST for appointment with an established West London manufacturing concern—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2409.XA) (December 20).

MATHEMATICAL PHYSICIST on the Staff of the Division of Radiophysics of the Council for Scientific and Industrial Research, Sydney—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2 (December 21).

LECTURER IN EXPERIMENTAL ZOOLOGY—The Registrar, The University, Liverpool (January 5).

LIBRARIANSHIP of the Bodleian Library—The Registrar, The University, Oxford (February 3).

RESEARCH CHEMIST, a RESEARCH ASSISTANT FOR MICROSCOPICAL DEPARTMENT, and one or more senior appointments and one junior appointment to the Liaison Department—The Director, British Leather Manufacturers' Research Association, 1–6 Nelson Square, London, S.E.1.

GRADUATE ASSISTANT MASTER qualified to teach Mathematics, Science and Engineering Drawing in the Junior Technical School and National Certificate Classes of the Ashton-under-Lyne Technical School—The Director of Education, 8 Warrington Street, Ashton-under-Lyne, Lancs.

TEACHER OF ENGINEERING DRAWING, with drawing office experience, in the Canterbury Technical Institute—The Director of Education, 78 London Road, Canterbury.

## REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

Re-Allocation of Man-Power between the Armed Forces and Civilian Employment during any Interim Period between the Defeat of Germany and the Defeat of Japan. (Cmd. 6548.) Pp. 4. (London: H.M. Stationery Office.) 1*d*. [410

Memorandum on Patent Law Reform. By Joint Chemical Committee. Part 1. Pp. 24. (London: Association of British Chemical Manufacturers.) 1*s*. [410

Institution of Professional Civil Servants. Post-War Reconstruction. Pp. 16. 6*d*. Post-War Reconstruction of the Technical Civil Service. Pp. 4. (London: Institution of Professional Civil Servants.) [510

The Status of Higher Technical Education. By Dr. T. J. Drakeley. Pp. 16. (Loughborough: Association of Technical Institutions.) 6*d*. [610

*British Journal of Surgery*. Special Issue: Penicillin in Warfare. Pp. 105–224+xxxii. (Bristol: J. Wright and Sons, Ltd.) 12*s*. 6*d*. net. [1110

Production Control in the Small Factory. (Office Aid to the Factory Series.) (B.S.1100: Part 2: 1944.) Pp. 26. (London: British Standards Institution.) 2*s*. [1110

Scientific Proceedings of the Royal Dublin Society. Vol. 23 (N.S.), No. 29: Studies in Peat, Part 13, Mona Wax and its Constituents as Emulsifying Agents. By J. C. Aherne and Dr. J. Reilly. Pp. 300–306. 1*s*. Vol. 23 (N.S.), No. 30: A Rapid Fermentation Method for the Production of Calcium Nitrate and Calcium Gluconate from Beet Molasses. By Oliver Roberts and Diarmuid Murphy. Pp. 307–314. 1*s*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [1210

### Other Countries

Ministry of Public Works, Egypt: Physical Department. Physical Department Paper No. 45: A Short Account of the Nile Basin. By Dr. H. E. Hurst. Pp. iv+77+9 plates. (Cairo: Government Press.) P.T. 40. [59

Indian Lac Cess Committee. Annual Report for the Year 1st April 1942 to 31st March 1943. Pp. 34. (Ranchi: Indian Lac Cess Committee.) [129

Bericht über das Geobotanische Forschungsinstitut Rübel in Zürich für das Jahr 1943. Von E. Rübel und W. Lüdi. Pp. 124. (Zürich: Geobotanische Forschungsinstitut Rübel.) [129

Indian Forest Leaflet No. 63: Studies on Adhesives, Part 9, Tar-Acid-Formaldehyde Resin Adhesives. By D. Narayanamurti and Kartar Singh. Pp. ii+19. (Dehra Dun: Forest Research Institute.) 6 annas; 7*d*. [149

Indian Forest Records (New Series). Utilization, Vol. 3, No. 5: Suitability and Selection of Timbers for Different Uses, Parts 1 and 2. By V. D. Limaye. Pp. ii+34+2+x+15 plates. (Dehra Dun: Forest Research Institute.) 6 annas; 7*d*., each Part. [149

League of Nations: Advisory Committee on Social Questions. Prevention of Prostitution: a Study of Measures adopted or under consideration particularly with regard to Minors. (Official No.: C.26.M.26.1943.IV.) Pp. 182. (Geneva: League of Nations; London: George Allen and Unwin, Ltd.) 6*s*. [149

Indian Forest Leaflet No. 62: Fireplaces. By J. L. Harrison. Pp. 8+4 plates. (Dehra Dun: Forest Research Institute.) 6 annas; 9*d*. [189

Bulletin of the American Museum of Natural History. Vol. 83, Art. 3: A New Fossil Whale from the Miocene of Peru. By Edwin H. Colbert. Pp. 195–216+plates 11–14. Vol. 83, Art. 4: A Collection of Fishes from the Panama Bight, Pacific Ocean. By John Treadwell Nichols and Robert Cushman Harvey. Pp. 217–260+plates 15–18. (New York: American Museum of Natural History.) [209

# NATURE

No. 3918 SATURDAY, DECEMBER 2, 1944 Vol. 154


## CONTENTS




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# POST-WAR FORESTRY IN GREAT BRITAIN

A LITTLE more than a year ago, the recommendations of H.M. Forestry Commissioners on the Post-War Forest Policy of Great Britain were reviewed in *Nature* (Sept. 25, 1943, p. 337). Their report (Cmd. 6447) was debated in both Houses in July 1943, receiving very general commendation and but little criticism. Meanwhile, the proposals have been receiving close attention from all who are especially interested in forestry, professionally or otherwise, and a good many reports and articles have appeared on the subject in newspapers and technical publications. Early this year, the Forestry Commissioners, after discussions with five of the leading societies interested in forestry, published a supplementary report on Private Woodlands (Cmd. 6500). A report on forestry policy has now been issued jointly by the Royal Scottish and Royal English Forestry Societies (Post-war Forestry, 1944)*, which include large numbers of woodland owners in their membership.

Though the figures for production of home-grown timber cannot yet be published, it is common knowledge that we have managed to meet the very large war-time demands for timber for all essential purposes despite very restricted imports. As the Forestry Commission has few plantations more than twenty years old, it is clear that private forests have had to shoulder by far the greater part of the burden, and the heavy demands on them are bound to continue for some considerable time yet. It can fairly be claimed, as it is in this report, that "in no other industry have the requirements of war-time so irretrievably destroyed the capital assets and the hope of profit for generations to come". Nearly a million acres of woodland in Britain will have been cleared in the two great wars of the present century. The rehabilitation of private woodland has accordingly a very strong claim to our most serious and early consideration.

In order to appreciate the proposals made in the Societies' report, it is necessary to recall the main features of the official policy that directly affect privately owned woodland. The first is the call for a considerable further increase of the total area under properly managed forest, the target being five million acres by the end of the next fifty years, with 1,100,000 acres to be planted in the first decade. This proposal has met with very general approval as both desirable and attainable, though the essential need for a stable policy and stable finance has everywhere been stressed.

The proposal then follows that, of the required five million acres, two million should come from privately owned woodland (which totals about three million acres in all), and a scheme for 'dedication' is put forward under which the owner undertakes: (i) to use the land in such a way that timber production is the main object; (ii) to work to a plan, to be approved by the forest authority, which would lay

* Post-War Forestry. A Report on Forest Policy prepared by the Royal Scottish Forestry Society and the Royal English Forestry Society. Pp. 62. (Roy. Scot. For. Soc., 8 Rutland Square, Edinburgh. Roy. Eng. For. Soc., 48 Dover Street, London, W.1, 1944.)

down the main operations to be undertaken; (iii) to employ skilled supervision; (iv) to keep adequate accounts.

In return for these undertakings, the owner will receive monetary grants which, after consultation, have been agreed at £7 10*s*. per acre planted and a maintenance grant of 2*s*. 6*d*. per annum for each acre of productive woodland for fifteen years, from the date of dedication or planting: these grants to be reviewed after five years, and loans to be available at the rate at which the forestry authority is financed. The originally proposed alternative of a refund of 25 per cent of net expenditure will remain open, and the owner will have to determine which alternative is the more advantageous to him—the relation between the extent and cost of the planting to be done and the value of the timber to be felled being the controlling factor. Many owners consider that the proposed grants are still inadequate, particularly that of 2*s*. 6*d*. per acre towards maintenance of young plantations, and this might well be doubled. It is also urged on good grounds that the grants should be free of income tax (unless taxed as a business under Schedule *D*). A further point to which attention is directed is that many woods felled during the War could not be cleaned up at the time and a grant should be made towards the cost of doing this prior to replanting: although a case can often be made out, it would obviously be necessary to find some means of doing justice to those who have managed to do the work notwithstanding difficulties.

The present report, however, makes a very strong case for the claim that the Forestry Commission has not encouraged private forestry to the extent that was contemplated in the report to which it largely owes its existence, namely, that of the Acland Committee of 1918, and that the new proposals do not appear likely to provide an adequate remedy. The Societies consider they have good grounds for their assertion that much that was called for has been left undone or has been done only half-heartedly, and that their own approaches have either been discouraged, or after eliciting some show of interest, have not resulted in any permanent improvement. They also now point out that the Forestry Commission seems to be content to take over a considerable part of the private woodland instead of viewing the extent of dedication as the measure of success, the alternative of transfer being a penalty, not an objective. It is for these reasons, and because they see in State forestry a very powerful competitor for markets and labour, that they are very insistent on the separation of State forests and estate woodlands at a high level of administration and control.

This difficult question of the post-war forest authority in Britain is perhaps the main subject of the Societies' report. The Commission's proposal is for its own maintenance in much the present form, though the possibility of its coming under a Minister (the Lord President of the Privy Council is suggested) is examined and some devolution of powers is suggested. For private woodlands, a special committee of the Commission is proposed, the two executive Commissioners (for England and Wales, and for Scotland respectively) having separate assistants for State forests and private woodland, and divisional officers—there are at present nine in England and Wales and four in Scotland—having separate staffs for the two types of forest ownership. Any such organization is quite unacceptable to the Societies voicing the owners' view, and they have put forward a plan of their own. The Commission, or Board, should consist of about twelve members under a nominated non-technical chairman. There would be four technical commissioners (paid officers, two for State forestry and two for estate woodland), five regional representatives (unpaid men of standing in forestry appointed after consultation with the forestry societies, two for England, two for Scotland and one for Wales), and representatives of the main political parties as at present. Further, there should be committees for England, Scotland and Wales respectively, including co-opted members. The present composition of the Forestry Commission is not such as could be expected to inspire foresters with confidence, and these proposals should remove some of the objections raised against the present arrangements. The question of Ministerial responsibility is discussed at length because it is difficult of solution: that it is desirable is agreed; but there are strong objections to giving that responsibility to the Ministry of Agriculture, and all are agreed that the administrative differences between Scotland and England must not be allowed to split responsibility for forestry, and with it the forestry authority itself. At the same time, very close liaison is essential between forestry and agriculture administrations.

A major point of difference between the views of the present Forestry Commission and the Royal Scottish and Royal English Forestry Societies is in the place and value of local executive committees with owner representation. The Commission repeats its view that unified control is necessary, and that advisory committees to the divisional officers are best calculated to secure the necessary contact with owners. The Societies—and it is clear that the considerable majority of owners and independent and informed critics are with them in this—are far from favourably impressed by the Commission's record in its relations with the various bodies set up with advisory or consultative functions; indeed, they consider that the War Agricultural Executive Committees have been successful enough to indicate that executive committees of a similar type should meet the special requirements of estate forestry equally well. They accordingly suggest the setting up of twenty to thirty regional forestry committees to collaborate with the same number of regional officers for estate woodlands, "advising and actively assisting them with regard to the prosecution of their duties" and "making recommendations for the expenditure of monies"; moreover, the committees are to "exert effective supervision over" the regional officers, who would work under the technical commissioners for estate woodlands, not under the conservators for national forests. It is also proposed to set up three central committees including representatives of these regional committees, and to provide

channels of appeal for both interests in case of disagreement. However, as it is recommended that each committee should at first consist of a part-time paid chairman, a vice-chairman and one other member appointed by the forestry authority, together with two members selected by the appropriate forestry society, and that its structure and powers should be reviewed after five years, it cannot be charged that it is desired to deprive the regional officer of the technical backing he must have if he is to carry on his work efficiently, but only to ensure that he is amply informed of local circumstances and opinion. The success of any such organization will depend very largely on the personalities concerned, and the result will consequently vary greatly from region to region: it is, however, worth a trial, on the understanding that considerable executive powers are assured to the regional officer.

A minor comment may here be interpolated in the form of an expression of the confident hope that the designation 'conservator' will be reserved for senior officers of administrative rank (with some twenty years service), as is the practice throughout the British Empire, and as indeed the Forestry Commission proposes to do in changing its present divisional officers to conservators. There should be no difficulty in finding suitable titles for the local officers.

Another of the Commissioners' proposals which has met with general disapproval is the deliberate withholding of help and encouragement in respect of small woods (limiting acreage undefined). The Commissioners have modified their proposals after discussion to the extent of agreeing that the standard planting grant of £7 10*s*. per acre should be payable on small woods, not being suitable for dedication (many will be suitable in company with larger woods), but the Societies consider that the rehabilitation and effective management of small woods in Britain, which comprise about one million acres, should be one of the main objectives in any national policy. They think that their own proposals, with regional officers and committees for estate woodlands, and particularly the active encouragement of co-operative organization, would accomplish this desirable end. The experience of the Scandinavian countries is quoted in support, and attention is directed to the fact that a small beginning has already been made in Britain despite the fact that the State assistance afforded to agricultural co-operatives is expressly withheld from forestry co-operatives—a position which should be amended in the expected new Forestry Act. This problem of the small woods is one which affects directly a very large number of owners, and indirectly almost the whole population, since it is these small woods in their tens of thousands which contribute one of the chief and treasured characteristics to the landscape of Britain.

Another matter on which public opinion is not satisfied is the supply of trained men, and the pay and prospects of those employed in forestry work, from the head woodman up to the higher personnel of the Forestry Commission. Perhaps the chief need is for more regular rates of pay for qualified head foresters and skilled head woodmen. To quote the report, there has been a "vicious circle of low or irregular rates of pay, a dearth of competent applicants, indifferent management and a belief that forestry cannot afford to pay an attractive wage". Shortage of rural housing has often worsened the position.

It is well known to foresters who have been faced with the problem of introducing planned management in previously unmanaged or mismanaged forests that progress is often determined more by the building up of an efficient technically trained staff than any other single factor. The Societies review the past and present facilities for meeting educational needs in forestry in Britain and find them extremely inadequate and far too exclusively devoted to training men for the State forests; they add some useful suggestions to those already put forward by the Forestry Commission.

Like almost every other informed critic, the Societies find the Forestry Commission's research programme totally inadequate in view of the general programme; how inadequate is perhaps best reflected by their comment that they would like to see the proposed allocation of funds trebled by the end of ten years. It may well be asked how anyone can, nowadays, in view of overwhelming evidence to the contrary, make the assertion that seed selection and tree breeding are not urgent matters when it is proposed to plant some 4½ million acres. It is probable that genetical work could best be done at a research station such as the John Innes Horticultural Institution to derive maximum benefit from existing knowledge and experience in the several highly specialized fields which together constitute genetics; but if the forestry authority does not stress the urgency of the work, contribute the special forestry point of view and facilities, and provide appropriate financial support, progress will be so slow that results will be obtained too late for the main opportunity for application, a position that has already prevailed in Britain far too long. A first step, one that could be taken immediately if belatedly, is to organize the selection of the best and most suitable stands of the important species, their reservation and tending for maximum seed production, and the collection, certification and distribution of seed from them, as is done in many Continental countries.

Then again, the economics of forestry, long neglected, should surely receive close attention and investigation in view of the proposal that the State should invest £41 million in the next ten years and should control private forestry as well. Forest management is closely linked up with economics and with land management generally, above all in estate forestry. The subject is not one which readily lends itself to the usual experimental research methods, but every wood the history of which is adequately recorded with costs constitutes in itself an economic experiment, and the research work to be done is a special comparative study of such experiments with the view of utilizing the results for better future management. The State proposes to scrutinize and approve the plans according to which dedicated woods are to be worked. What, it might

very well be asked, does the State forest staff know about the management of estate woodlands ? Granted they may now have more experience of large-scale plantation work in Britain than anyone else, but every professional forester knows that modern forest management is conspicuously absent from Britain, beginning with the Crown forests such as the New Forest and the Forest of Dean, while university instructors complain that they still have to take their students to the Continent to demonstrate the results of organized forest management.

Efficient management is to a very large extent conditional on the existence of adequate markets at prices yielding a margin over costs of production. Steps must accordingly be taken to develop markets for home-grown forest products, and to ensure that the State forests share them with estate woodlands. Markets for the large amounts of material of small dimensions available from thinnings in plantations are the chief need; in fact, it is hard to see how forestry can flourish without them. Possible measures to this end cannot be discussed here.

Opinion is perhaps not so unanimous as to the need for special research on forest engineering problems. Thus many take the view that the necessary vehicles needed for extraction of forest produce over rough, cheaply built roads have already been developed for war purposes, and that industry can be relied on to devise improvements in tools, etc., once the need is made clear.

A further question that arises here is the administration of forestry research. Opinion among foresters seems definitely that it would not benefit by being transferred from the forestry authority to the Agricultural Research Council; but that the present arrangement, under which the forestry authority consults a purely advisory committee, is unsatisfactory. The suggestion is that this committee should be strengthened by including greater representation of experienced foresters and by giving it much increased powers.

This review may be concluded on a note of warning. The need for a big extension and overall improvement of the practice of forestry in Great Britain is unquestionable: much of the work should have been done long ago and it behoves us to make up for lost time, but there is no field in which the motto *festina lente* is more appropriate than in forestry, where mistakes are likely to persist to mock one through several human generations. The Forestry Commission's new programme, commendable though it is in most of its items, flouts this motto in several respects. We have planted nearly half a million acres in the past twenty years, during which time we could without undue effort have won far more knowledge valuable for application to the next decade than we have. It is now proposed that we rush into a much bigger programme, and extend State control over private woodlands, not even allowing ourselves time to train the necessary personnel thoroughly. Surely the sound policy is to carry on at a more moderate rate within the competence of the available staff, and to put a considerable part of our new effort into research for application to our afforestation work. The ground that may be lost by proceeding cautiously during an initial period of thorough training and research, surveying and planning, can easily be made up by a later gradual planned expansion of the work, and its overall quality would certainly be considerably raised. The British Empire has established a high international reputation for its forestry work in India over the last seventy-five years: a start has been made in Great Britain, but our progress in all respects, except that of acreage under new plantations, has been so inadequate that we have if anything lost ground against the general advance. Let us make sure we do all in our power to start the coming post-war era on the best possible lines; and there is no aspect of British forestry which calls more insistently for improvement than estate forestry, so let us see that its special problems receive the attention which is their due.

## INTERPERSONAL RELATIONS IN EDUCATIONAL PRACTICE

The Social Psychology of Education
An Introduction and Guide to its Study. By Dr. C. M. Fleming. (International Library of Sociology and Social Reconstruction.) Pp. viii+110. (London: Kegan Paul and Co., Ltd., 1944.) 7*s*. 6*d*. net.

AN interesting trend in modern education is the declining concern with mere formal aspects of the mind, with attention, memory, reasoning, judgment and so forth. This has yielded to a new emphasis upon the child or pupil as a personality, as a social organism, as a member of diverse groups. The child's cognitive equipment is now seen in better perspective against his personal and home background, his emotions, attitudes, incentives and social orientation. Education ceases to be a study of rational faculties occasionally and accidentally disturbed by errors or by the vagaries of temperament. Perhaps the chief merit of Dr. Fleming's book lies in bringing home to the reader this change in education from being a cold, academic exercise to becoming a realistic guide in meeting the emotional, intellectual and social problems of the developing child and continually adjusting adult. Gently taking the teacher by the hand, Dr. Fleming leads him from his pedestal and shows him how to mingle easily among those he seeks to educate; the reciprocal influences between teacher and taught are now brought into fresh focus. The author's exposition is not, however, confined to the class-room. Wherever educative processes are discernible, at home, in office or factory, in clubs or institutions, the common principles of interpersonal relations are shown to be active between the educator and his charge.

Part 1 deals first with the deliberate or unwitting manœuvres and tactics, so to speak, which the teacher and pupils employ in establishing and maintaining their respective positions. This leads to a consideration of the modifiability of individuals and groups of which they are members, as a result of the mutual interaction between them. Part 2 traces the converging influences of family, community, school and other groups on the developing child. Part 3 (inappropriately called "Teachers are also Persons") is mainly concerned with the criteria of emotional maturity, and Part 4 with the treatment of educational failures.

Not only in Part 1 but also throughout the book, attention is rightly and repeatedly directed to the changeability of almost the whole range of conduct as contrasted with the limited number of traits the relative fixity of which is so often exaggerated in importance. A significant corollary follows. Selection for different kinds of schooling, and classification on the basis of aptitudes, are not ends in themselves but a means to better tuition and guidance. A clear distinction must be kept between the supposed limits of an individual's educability, on one hand, and the possibilities within those limits, on the other. Current test scores and mental ratios may provide some index of the former; they are of little use by themselves in regard to the latter. But it is precisely here that the educator's chief task lies.

The guiding principle in the book is the idea that the essential characteristic of behaviour is its specificity, due to the particular social and material circumstances in which it occurs. Traits of personality are therefore represented as relations rather than as qualities, that is, as functions of the interaction between the individual and his environment, not as inherent in the individual. For example, leadership —a topic to which Dr. Fleming gives some prominence —is conceived as a part which a person may play in a suitable situation, not as an intrinsic or general quality like intelligence or stature which he always has with him, so to speak, and displays on all occasions. On this theory, the same individual might take the lead as a matter of course in some situations and be content to follow in others. Differentiation into leader and led would be determined by the configuration of interpersonal relationships whether in class-room, playing-field, debating club, political gathering, military crisis or social emergency. This view involves a rejection of the notion, still favoured by some older academic psychologists in Great Britain, of conduct being relatively consistent, fixed and almost predetermined by a set of inborn propensities. Dr. Fleming also discounts the importance of general and type factors in personality, a departure from current teaching which it is not so easy to justify and which should be further explored. It is important to note that although the conception of general factors in personality, the conception, that is, of basic tendencies manifesting themselves in similar ways in diverse situations, owes its statistical development largely to those who think in terms of a framework of instincts, it does not necessarily stand or fall with the latter.

Quite a few of the author's views seem to be intuitive rather than objective in basis. The theory that leadership qualities are specific (p. 25) is a case in point, however plausible it may sound. Another instance is the statement (p. 18) that a basic need for personal independence manifests itself at an early age in the need for possessions. This is not in accord with reports of social anthropologists (for example, Margaret Mead), or with observations of infant behaviour generally. In observing very young infants, one cannot help being struck by the way they cast aside any object after the momentary attraction has passed. They are, in fact, incapable of a complex trait like possessiveness by virtue of their limited 'temporal span', if by possessiveness is implied awareness of ownership.

More care might have been taken in the chapter on "Family Influences". The observation (p. 41) that "the measured intelligence of children may differ *somewhat* [italics mine] from that of their parents" certainly does not convey the limited predictive efficiency of a coefficient of correlation of 0·5 between the test intelligence of mid-parent and child cited by the author in the previous paragraph. Precision is also lacking in the remark (p. 41), "about 80 per cent. of feeblemindedness has been attributed to inheritance", while the statement (p. 42), "all delinquents do not come of criminal ancestry", though logically sound, gives an exaggerated notion of the importance of heredity in view of the fact that the proportion of ascertained delinquency with criminal inheritance is probably in the region of 15 per cent. There is little justification for the following sweeping generalization about such a heterogeneous group as juvenile delinquents: "on the whole, the evidence is that children showing delinquent tendencies come from unwholesome homes and that their emotional maladjustments are accompanied by emotional maladjustments on the part of the parents" (p. 42). There is nothing in this statement to suggest that the author appreciates the "plurality of converging causes" (Burt) to which, as is widely accepted, delinquency is due.

Some passages have rather a casual air about them, particularly those dealing with growth (p. 62). What, for example, is the reader expected to make of the observation "prediction [of physical and mental growth], except for averages of groups, is extremely hazardous, and even that is hazardous during the period of adolescence"?

These minor criticisms should not, however, deter students and practitioners of education alike from reading this fresh and stimulating approach to the social aspects of their problems. JOHN COHEN.

# CHEMISTRY AND ATOMIC STRUCTURE

**Recent Advances in Physical and Inorganic Chemistry**
By Prof. Alfred W. Stewart and Dr. Cecil L. Wilson. Seventh edition. Pp. xii+512+5 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1944.) 28*s*. net.

IN an attempt to keep pace with the remarkable advances in physical and inorganic chemistry since the sixth edition of this useful work was published, Prof. Stewart has made some drastic changes which have greatly increased its value. Dr. C. L. Wilson has contributed eight new chapters and has revised the rest.

Our ideas on atomic structure have undergone considerable change during the interval. The discovery of deuterium introduced a novel feature, for we have in hydrogen and deuterium two isotopes which differ so widely in atomic mass that they act like different elements. Not only is there an entirely new range of compounds to examine, but also a serious revision of physical constants is involved. It has been shown that although the atom may give rise to quite a number of different particles, namely, protons, neutrons, deuterons, electrons, positrons, α-particles and mesons, each of which is discussed in turn, the present view is that the nucleus is composed only of protons and neutrons. The mechanism whereby the other sub-atomic particles are projected is still uncertain. The high voltages produced by the cyclotron have given us high-speed protons, deuterons and α-particles. Neutrons can now be obtained by bombarding beryllium with high-speed deuterons instead of α-particles. Since a neutron carries no charge, it

is not repulsed by the nucleus and has therefore great penetrating power. Fermi has shown that all the elements from 7 to 72, when bombarded with neutrons, give radioactive products, whereas only the first twenty are disintegrated by charged particles.

Isotopes with different radioactivities but alike in both charge and mass are rarely encountered among natural radioactive products but can now be produced artificially. The difference between these so-called nuclear isomers is one of energy content. Interesting examples are given by the bombardment of indium by fast neutrons. The rather complex results, which are not all radioactive products, are illustrated diagrammatically. The nucleus, which is at first excited to a higher energy-level by impact with the accelerated neutron, may return to the ground state by losing $\gamma$-radiation; but more frequently $\beta$-radiation is observed instead, the emitted electron being orbital and not nuclear. Theories of extra-nuclear electronic structure are discussed historically, and it is shown that the use of the four quantum numbers leads to a probable distribution of electrons.

X-ray diffraction has probably been the most powerful single physical method devised for the ultimate analysis of matter. It has laid bare the structures not only of the diamond, graphite and alloys, but also of textile fibres and other complex molecules, and it has clarified our views on valency. Robertson has achieved remarkable success in plotting electron densities as a series of contour lines with the aid of a Fourier analysis. Electrons can also be diffracted, and although they are much less penetrating than X-rays they are much more active photographically and are well suited for examining tarnish films on metals. Atomic linkages can be measured by electron diffraction; and by using the electron microscope, a description of which is given, it is possible to photograph particles which are only 30 A. in diameter.

The chapter on conductance gives a clear account of the gradual development of the theories of ionic behaviour. The anomalies of strong electrolytes are still not completely solved, but the theory of complete ionization even in the solid state probably rests on a sure foundation, since such compounds act in a fashion entirely consonant with what is known of their fine structure.

## AGRICULTURE IN URUGUAY

**Investigaciones Agronómicas**

Por Prof. Alberto Boerger. Tomo 1: Fundamentos de la Producción Vegetal. Pp. 758. Tomo 2: Genética; Fitotecnica Rioplatense. Pp. 1,043. Tomo 3: La Producción y el Hombre. Pp. 443. (Montevideo: A. Barreiro y Ramos S.A., 1943.) n.p.

THIS compendious work is difficult to appreciate. It is built around the investigations of the Uruguayan agricultural experiment station "La Estanzuela". The researches of this station are discussed in summary form in the text wherever they bear upon the general problems discussed; copious indexes and a full bibliography of the station's publications (commencing in 1912) are given. No complete chronicle or map of the station is supplied, and it is difficult to find a statement of its position. The book discusses many broad problems having a bearing on husbandry, including methods of investigation, laws of yield, mixed crops, autarky, and the system of Henry George; and sometimes gives unexpected information, such as a survey of the organization of plant genetical inquiry in the Argentine, Uruguay and the Brazilian province of Rio Grande do Sul.

The book supplies many climatological data, but is no general statistical digest, and only incidentally yields information about agronomic practice in Uruguay and adjoining regions. Thus, from the description of a trial of rate of sowing of linseed, the reader can deduce that the normal rate of sowing must be about 70 kgm. of seed per hectare. Several factors affecting yield of the more important crops are thus brought to light, but no explicit information about local practice is given. The most important problem of selection before the Uruguayan wheat industry is stated to arise from the need of finding varieties not markedly affected by the date of sowing—which means, in effect, that what is wanted is wheat which will grow independently of the peculiar vagaries of the climate. It is a heartening sign that this and some other problems are reviewed regionally—with respect to the La Plata basin—and not merely nationally.

The author's interests are frankly in crop problems, and he includes many references to the relation between crops and livestock; but it may not be unfair to point out that the information about soils is less thorough than is warranted by the connexion between soils and plant growth. The deficiencies of agricultural investigation in South America seem to be those of a 'prairie' country of extensive agriculture where any established crop will grow more or less well, so that the obvious problems are on the surface; it is relevant to note that erosion is attracting attention, but that nothing much has been done about it yet except talking and writing in such general terms as those of this book.

The work may perhaps be summed up as the expression of the experience of one of the older generation of experimenters, who not only reviews the work of his own station but also includes the salient features of many problems to the solution of which the station has not contributed. If the book is regarded as a pool of some South American thought, it is legitimate to ask what streams have contributed to it and what it reflects.

Several tributes are paid to the work of R. A. Fisher and the revolution which his school of mathematical statisticians has effected in experimental technique. Fisher's methods have been extensively used in Uruguay and the Argentine by G. J. Fischer and others, and the book gives full acknowledgment to Fischer's work at least in so far as it emanates from La Estanzuela; this may outweigh the fact that no very recent European work on mathematical statistics is quoted. No later edition of Sir John Russell's "Soil Conditions and Plant Growth" is mentioned than the Spanish version of the sixth edition (1934); and Russell's review of the Woburn experiments, issued in book form in England, is quoted from a German abstract. In general, it seems that the author is better acquainted with recent Continental work than with British. The apparent tendency to ignore recent British contributions to agricultural science seems to lie deeper than a purely war-time shortage of books and other means of communication of ideas; though, if that shortage persists, the insulation of South America from British cultural and scientific ideas may become more serious.

HUGH NICOL.

### The Journal of the Institute of Metals

Vol. 69, 1943. Edited by N. B. Vaughan. Pp. xxxvi+526+41 plates. (London: Institute of Metals, 1943.) n.p.

THE "Journal of the Institute of Metals" has acquired a very high reputation as a medium for the publication of the results of research upon the alloys of the non-ferrous metals. Despite the distractions of war, this reputation is thoroughly maintained in the volume under review. Starting off with a joint discussion with the Institute of Physics on the application of X-ray methods in the investigation of the equilibrium diagrams of metals, it contains some two dozen other papers on corrosion and surface protection, the structure of rolled aluminium and brass, spectrographic analysis, electron diffraction—the thirty-third May Lecture by Sir George Thomson—a thermodynamic study of the ageing of the copper-aluminium alloys by Prof. S. T. Konobeevski, of Moscow, together with many papers on the metallography of the light alloys of aluminium and magnesium.

It should by now be unnecessary to stress the fact that the high standard of the Institute's papers remains unaffected. Considering the difficulties of the times, this volume is a most creditable achievement, on which everyone concerned, and not least the editor, Mr. N. B. Vaughan, is to be highly congratulated.

F. C. THOMPSON.

### The Chemistry of Life

An Easy Outline of Biochemistry. By Dr. J. S. D. Bacon. (Thinker's Library, No. 103.) Pp. ix+118. (London: Watts and Co., Ltd., 1944.) 2s. 6d. net.

IT is a difficult task to write a book about a technical subject in non-technical language without floundering hopelessly in a mass of words. The author has overcome this by simply explaining these technical terms when they must be mentioned. The underlying idea is that biochemistry is the understanding and interpretation of living processes on the basis of chemical transformations which are capable of precise measurements. Recent methods used as tools by the biochemist, such as ultra-centrifugation, dialysis, electron microscopy, labelling with isotopes and respiration methods, are described. Mention is made of enzymes, hormones, evocators, genes, chemotherapy, viruses and bacteriophage. A useful feature is a glossary of technical terms, although it is doubtful whether understanding, for example, of the terms 'crystalloid' and 'purine' is increased by defining them respectively as "soluble substances of low molecular weight" and "a class of organic substances containing nitrogen with a characteristic molecular structure".

T. F. DIXON.

### Gérmen e Cultura

Por Prof. A. A. Mendes Corrêa. Pp. viii+234. (Pôrto: Instituto de Antropologia da Universidade do Pôrto, 1944.) n.p.

THE author would be the last person to claim that this volume contained new and important information. His aim has been rather to sit back and survey a number of problems and to give us his ideas generally: the articles included are, as it were, conversation pieces, some being on subjects of universal interest, others on matters of more particular importance to the Portuguese themselves and to their offspring in the New World. Such a series of conversation pieces, when composed by a scholar and humanist like the Director of the Institute of Anthropology of the University of Oporto, are always worth reading, and they will be found to be a useful antidote to the procession of single-track ideas generated by the overpowering pressure of the War. Portugal, it must always be remembered, is one of the few countries of Europe that has remained at peace.

The articles included in this volume are on various subjects and of different lengths. Most of them were delivered in the first instance as addresses to meetings of learned societies held in Portugal during the last few years. The title of the book is taken from that of one of the articles. Others deal with prehistory and history in Portugal, with the ethnology of Brazil, with the science of population, with methods of combating degenerative factors present in the Portuguese people, with half-breeds, with rhythm and culture, with the passage to sovereignty from bondage, etc. It is all somewhat general and philosophic, but none the less pleasant for that; a book well worth perusal by the fireside.

M. C. BURKITT.

### The Blood Pressure and its Disorders, including Angina Pectoris

By Dr. John Plesch. Pp. viii+149+5 plates. (London: Baillière, Tindall and Cox, 1944.) 15s. net.

DR. PLESCH divides his book into three parts. Part 1 contains a description of the principles and construction of an instrument which records the pressure changes within the brachial artery when this vessel is subjected to compression. The variations in the records obtained in different cardiac and peripheral vascular diseases are discussed. There is much useful clinical and physiological information in this part of the book, but the arrangement of the material makes it difficult to discover. As an additional instrument in the armamentarium of the cardiologist it is of considerable value, but it does not replace familiar and well-tried methods of diagnosis.

Part 2 is devoted to a discussion of the venous pressure and its variations in health and disease. This discussion covers a wide range and again contains many observations and hypotheses of interest to both clinician and physiologist.

Part 3 takes up the special condition known as angina pectoris, and discusses its pathology, physiology and treatment.

The book suffers much from the absence of a bibliography. Various authors are quoted in the text, but no references are given to their publications. The work of American and British investigators in the field of cardiology and vascular physiology receives scant attention.

### Metallurgical Abstracts (General and Non-Ferrous)

Vol. 10, 1943 (New Series). Edited by N. B. Vaughan. Pp. xii+523. (London: Institute of Metals, 1943.) n.p.

THE "Metallurgical Abstracts" of work which comes within its own sphere is by no means the least valuable part of the activities of the Institute of Metals. The subject index alone of the volume under review extends to thirty-eight double-column pages, an indication in itself of the thoroughness with which the work is done. It will suffice for all those who have known this series of abstracts in the past to say that the latest addition is in every way up to the usual standard.

# CHEMISTRY IN THE SERVICE OF MAN*

By Dr. E. F. ARMSTRONG, F.R.S.

CHEMISTRY is the science which has discovered how things are composed, what properties they have and how they will react. Chemistry not only tells all about natural substances but also enables us to make new products rivalling the natural products in utility. Some of these safeguard health, others provide clothing, propel motor-cars, do a thousand other things and promise much more in future.

The manufacture by chemical synthesis of thousands of tons of substances of use to man depends on the availability of large quantities of suitable raw materials. The chemist wishing to make carbon compounds, which are without exception made up of longer or shorter chains of carbon atoms joined one to the other, seeks to start as early in the series as possible, generally from substances containing only two carbon atoms represented thus — C — C — in his graphic formulæ.

To found a large-scale industry which is to handle many tens of thousands of tons, the raw material must be available in plenty and at world prices. It must bear no tax at this stage, a point largely overlooked by our politicians, or any other avoidable burden; in short, the price must be as low here in Britain as it is anywhere else in the world if the home industry is to be competitive.

The problem in making the large molecules or polymers composed of repeating units, which constitute many of the plastic materials, is to induce a large number of relatively small molecules to join together by chemical means. It would be a difficult and costly operation if we had to build the large molecule step by step; fortunately there is a trigger-like action between two carbon units at a high temperature, so that the energy set loose when they combine brings about a chain reaction in which perhaps a thousand units join together. The chemist has learned how to control the growth of the molecule so that the most suitable molecule-length may be obtained to suit the particular purpose for which the polymer is to be used.

The search for raw materials thus becomes one for two-carbon compounds; there are several alternative sources of these which it is proposed to examine here primarily in relation to their availability in Britain and the British Empire.

(1) Acetylene made by the action of water on calcium carbide, which in its turn is made from lime and coke by processes which need very large quantities of electric power: this power must necessarily be low-priced. In general such power, either in quantity or price, is not available in Britain, and it is not considered that any of the carbide production will be available for chemical synthesis.

(2) Two-carbon compounds made from alcohol by simple large-scale processes. Industrial alcohol is made by fermentation of carbohydrate materials, in particular from molasses which is imported in tank steamers just as is crude oil. It is recovered from the spent mash by distillation: other commercial products of the operation are carbon dioxide used to make 'dry ice' for refrigeration, and yeast. The formation of fermentable carbohydrates by plants is largely a function of the amount of sunlight—tropical countries have a great advantage over Britain in this respect. Our home cereals, required to feed man and beast, are too valuable to turn into alcohol except that limited quantity which is so profitably sold as potable spirits. The West Indian and other colonies need an outlet for their surplus carbohydrate material, and it is probable that industries can be developed there on the largest scale to produce material which can be easily transported to Britain for fermentation to alcohol.

(3) Two-carbon compounds made by the cracking of petroleum products. This industry is a modern adjunct to the refining industry which makes petrol, lubricating oils and burning oils.

(4) Two-carbon compounds made by catalytic synthesis from water gas and hydrogen. As water gas is made from coke, this is a simple form of oil from coal.

The oil-refining industry is only to a very minor extent established in Great Britain, since the discovery of a small native source of petroleum is a recent one. An increasing number of people consider its absence to be a very serious handicap, both because the country is deprived of these cracking products as the basis of the new chemical industry and because also the lack of this industry will mean the loss of incentive to our young men to become chemical engineers, of which more anon. The economic future of the synthetic, often called the Fischer Tropsch, process is still uncertain. It has been largely developed in Germany for military considerations.

Apparently if Britain is to develop these new synthetic chemical industries, the raw materials will be alcohol and/or cracking products. Both are being used to-day in America and there is the keenest competition between them, for example, as to which is the best raw material for the manufacture of synthetic rubber. Reports seem to indicate that the alcohol process is coming out well, which is of good augury for Great Britain where, as my analysis shows, it may be the most readily obtained raw material.

There is a great future for agriculture to supply raw materials, especially for chemical industry, sometimes called chemurgical materials. The sun and the rain and the soil enable man by the sweat of his brow to produce foodstuffs for man and beast. It is a wasteful process; too much depends on a variable market with manipulated prices, and much that is grown is left to decompose into simple products which return to the soil and the air. With cheap transport available and good organization, it should be possible to transform far more of what is grown into alcohol or protein and to lessen the waste. If this can be realized, great new employing industries can be set up in Britain and every yard of ground will be turned to account.

Lord Bledisloe has quoted with approval a statement "this nonsense world has too much chemistry, forgetting the living earth". Perhaps he is right in relation to farming, but reference is here made to the use of farm products as raw materials. In fact, there is need for more chemistry to help use the products of the farm, and we cannot do better than quote Mr. G. A. Sloan, president of the Nutrition Foundation:

"We think of cattle, corn, peanuts and soya beans primarily as food. In the future we will think of them also as sources of penicillin, synthetic fibres, hormones, vitamins, plastics and a host of new products which

* Extracts from the inaugural address to the Royal Society of Arts, delivered on November 1.

will increase the return to the farmers who raise them."

Some say we have not room to grow carbohydrates for alcohol in Britain, since we have only $1\frac{1}{4}$ acres per head of population. At least, we can avoid much waste, and there is the whole of the British Empire.

War experience has already taught that there is an economic use for all we grow when scarcity makes us take heed of our resources. Chickens, pigs, animal meat are not economic; milk production is! It is claimed, though not yet proved, that the yield of protein per acre in the form of yeast made from molasses calculated on the area of land required for the production of the molasses is several times greater than that of protein grown as soya beans, which have a high content of protein. It is also higher per acre than that obtained by feeding fodder crops to animals. In other words, 100 acres of sugar beet turned into molasses, turned into yeast would give more protein than 100 acres of grazing land turned into beef. These are the kind of sums which we may have to work out in the future.

The chemist has done much for food and will do increasingly more. There is an entirely proper prejudice in favour of fresh untreated foods; but we must, at least, know and understand everything about each one of them, and where the chemist can aid to make them safer to eat, more available, and guide their choice, his help should not be refused.

I wish here to direct attention to another phase of the food question, namely, that concerning proteins. Each protein is made up of a number of molecules of amino-acids, of which there are twenty different kinds. The protein molecules are very large, containing a thousand and more amino-acid molecules; they differ in the percentages of the various amino-acids present and may lack some of them altogether or contain the smallest quantities only. The individual amino-acids are joined end to end in a chain, the exact pattern of which has not yet been established for any protein; it is known to be constant for each particular protein.

The body breaks down the proteins, it eats into the individual amino-acids and uses these again to make its own protein: hence the importance of the individual amino-acids. Man and animals need most of them. Probably meat protein is so important a food because it contains those very amino-acids which we use to make muscle tissue. Nutrition experts are quite clear that a mixed diet is the best as a source of protein.

The scarcity, at least in war, and the cost of proteins make their economic production a matter of extreme importance. One main source is meat from animals, which convert vegetable protein in herbage into beef and mutton and pork; the process is a slow one. Another source is the pulses, seeds of high protein content which can be improved by selection and cultivation. Another source is fish.

The widespread cultivation of the soya bean is a notable example of progress in protein production. Unfortunately, this vegetable protein only ranks as second-class. Considerable interest, therefore, is attached to the production of protein in the form of yeast, which can be multiplied very rapidly in the course of a few hours. Whereas animals make their protein from the small amounts of organic vegetable protein in the very large quantities of herbage which they consume, the yeast cell is able to make its protein from ammonium salts, which are inorganic and manufactured from the nitrogen in the air. The technical question becomes whether yeast can be made in large quantity from carbohydrate material and inorganic nitrogen (ammonia) at a competitive price with meat. Inorganic nitrogen, a product of high-pressure technique, is to-day very cheap and available in unlimited quantity.

It is worth while giving some data about yeast production. They are based on U.S. experience. Baker's yeast is the chief yeast product; it is made to-day from carefully cultured strains having standardized activity in causing bread dough to rise in an appropriate number of minutes. Some 100,000 tons will be made in 1944. The vitamin content is not high, but it is possible to enhance it by changing the nutrient. Brewers' yeast is essentially a by-product of the fermentation of beer, and is not a raw material for another industry—more than 12,000 tons are available as a slurry, of which about one-third is recovered as cattle food and about one-tenth used as food or sold in the pharmacy. The vitamin content is some three times as great as that of bakers' yeast. The acceptance of brewers' yeast as food has led to the production in America of this type, grown especially for the yeast, that is, without hops, so that the product need not be debittered. The dried yeast has a high content of the vitamin B complex and retails for some 3*s*. a pound, a price which is reasonable on the basis of its protein content, which is about 46 per cent. A little calculation shows that yeast protein costs about 6*s*. 6*d*. per pound retail, whereas beef, with 19 per cent protein, selling at 2*s*. a pound, involves a protein cost of 11*s*. a pound. These figures are but an indication, but they are very suggestive of what can be done in the way of making protein quickly. Beef protein takes a year or more to make, yeast protein is a matter of twenty-four hours; beef certainly needs a larger acreage.

A specially suitable race of the yeast (*Torula utilis*) for the purpose has been recently developed in London, and factories are understood to be under construction to make it in Jamaica and Mauritius, where its first use will be for the under-nourished children in those Colonies. In the tropics, protein scarcity is often severe, but waste carbohydrates are plentiful. Certain races of yeast multiply so rapidly that the alcoholic fermentation is practically negligible. The yield of dried yeast in practice is 60 per cent of the fermentable sugar. It has been estimated in Germany that the waste sulphite liquors of the paper mills could make 100,000 tons of dry yeast a year, equivalent to 50,000 tons of protein. A development which is not very remote is the making of fermentable carbohydrates from wood. By what is known as the Scholler process, wood in presence of dilute sulphuric acid at a pressure of 4 atmospheres, the temperature being taken up to 190° C., is converted into easily fermentable glucose.

Largely within one generation, Britain and the United States have passed from a stage in which most of our food supply went directly from the farm to the consumer, to the present development in which the food industry processes and distributes a large and growing part of the total food supply. This could not have happened had it not been possible for the industry to do the job more efficiently, to provide better foods for the public at low cost. At first the development appeared to be on wrong lines from the point of view of optimum health, but the timely discovery of the importance of vitamins and the way to preserve and, indeed, obtain them has

altered this and made industry distribution of food of real benefit to mankind.

I would say a word about chemistry as a career. The nation needs many thousands of chemists, and the profession will attract an increasing number of young men. But the need is for enthusiasts with a real call to study and discover and make the furtherance of chemistry their life-work; those who think only that chemistry will give them an easy livelihood should be discouraged from entering the profession.

There will be countless opportunities in industry, in research and teaching, as well as in the professional branches of chemistry—the wise man will try to get experience in several of these before he settles down to his preference. While the material reward is important, and chemists, like others, must be properly paid, it is not everything, and many must be left free to pursue science for its own sake.

There is a tendency to place the utilitarian aspect of science too high, to associate universities, teachers and research with industrial development. This may have grave dangers if pursued too far; the universities must be left unfettered to pursue pure science, and endowed so as to make this possible. Their main function must remain to advance science for its own sake and they must avoid becoming tied to the wheel of commerce. "The wind of genius bloweth where it listeth."

In advocating the much more general teaching of science and scientific method throughout the schools, it is the scientific habit of thought that it is desired to cultivate, not mere scientific knowledge. The so-called practical man affects to despise theory, but he usually has a fairly intimate knowledge of his materials, gained by long experience, while if he is really practical, his methods are not far different from those of science. Where a knowledge of scientific method can help is in enabling new experiments to be devised which have a fair chance of success, or at least of teaching something. I have seen to my sorrow during this War far too many costly experiments made, the result of which a scientific man with knowledge could have easily predicted and which, therefore, were a waste of time and money.

The engineer, who is largely ruled by tradition, has intimate knowledge of the metals, but is being faced with the most varied requirements by industry for special plant to work at high temperatures and pressures, and to contain substances with corrosive and other unpleasant properties. To meet these difficulties a new class of engineer has arisen, the so-called chemical engineer, who supplements a sound general knowledge of engineering by a specialized knowledge of applied chemistry. There are degree courses at certain British universities for the training of such men. Actually, the country needs a great many more of them, perhaps several thousands, and the facilities for training them must be immediately increased.

I like to think of chemists as voyagers to a New World on uncharted seas of discovery, possessed of an Elizabethan quality as merchant adventurers. The Elizabethan age was one which had a soaring confidence; statesmen were not afraid to be something else as well—Bacon was alike man of science and philosopher. Science, industry, commerce, require art and skill to guide them; they need vitality for creative effort. It is our task to help to find them. It is not enough to search for true knowledge, for it is in the use of that knowledge we shall build our future.

The influence of war in accelerating scientific progress is often made the subject of comment. The reason for the greatly accelerated tempo is not far to seek—the needs are urgent, money is of no object, large-scale experiments are made possible, ample man-power is available. To Napoleon is credited the introduction of sugar beet in France to substitute for the West Indian sugar denied him by the blockade of the English Fleet; he also began the research which led to the preservation of foods by canning. This War has taken food preservation a stage further and developed the dehydration processing of food and much beside in the food industry: transport difficulties brought about by the submarine have forced these developments and produced a revolution, internal and external, in methods of transporting and preserving foodstuffs. Margarine was introduced during the 1870 War, but its development lagged until the War of 1914–18, and has been completed during this War, so as to put it on parity with butter. Perhaps the chief effect will be the great simplification of the problem of distributing food on a world-wide scale. Places and countries which are far distant, hard to reach and unhealthy, can now have normal healthy food supplies assured. Given also the advantages of refrigeration and air-conditioning, with power produced by the petrol engine, pioneering will lose half its terrors, while airports will become oases in the most savage lands.

Perhaps the person who is really encouraged by war is the technologist; hence the rather crude saying that science is useless until the technologist comes along and does something with the findings. Britain has made more than its quota contribution to discovery in pure research; it has largely left it to other nations to turn these discoveries to practical ends, and it is very slow to adopt them even when they are proved and of economic value.

It is comforting to read that even in the United States, where the speed of technical development is a cause for envy here, 'neophobia' exists, a term which means 'fear of the new' and that it may take ten or twenty years for a new product to become commercially successful. A wise friend of mine, H. A. Hopf, writes me that "every sensible person whose ideas are in advance of his times must have patience and persistence and a sense of humor".

It is claimed, and with a large degree of truth, that science, meaning the knowledge we have to-day in its various branches, has put those things which the individual wants, namely, food, work, security and freedom, within reach of all. The methods and ideas of science must become the dominant forms of thought and action in the future, but we must watch that talk is not substituted for action. Very few of those who offer Utopia to the public suggest that hard work will also be necessary and, indeed, must come first, if Utopia is to be earned. Forgotten is what Gilbert Cannan once expressed in "Pigs and Peacocks"—"laziness is the source of the whole trouble, letting the language, the traditions, the morals, the justice and the liberty of the race slip away"; there will be many who think this is just what is happening to-day.

It is widely advocated that the man of science and the engineer must exhibit depth and breadth of learning, and in particular see that the gifts of science are not wrongly used. The intention is good, but no man can control what others do with his inventions or their development. In fact, the developments during war, into which no question of econ-

omics is allowed to enter, are enormously greater and faster than they would have been during peace, and when peace comes mankind is assured of amazing benefits through them.

There is a hypothesis widely held by modern leaders of thought that the evolution of society, moving at an ever faster pace under the impetus given it by modern science, has up to now outstripped the capacity of human beings to adapt themselves. It is asked in the words of Herbert Read, "Is there a pattern or is it chaos; is it empty turmoil or is it progress?" That the world needs skill and vision to rebuild none will gainsay. Can we not say we are men of science and we believe we have the skill; we are artists and we believe we have the vision? Herein lies the future of this Royal Society of Arts. Shall we not repeat those Biblical words: "Be ye doers of the word and not hearers only, deceiving your own selves".

Perhaps then we may say with Shelley:

"The world's great age begins anew
The golden years return".

or with Carlyle: "Blessed is the man who has found his work—let him ask no further blessedness".

## THE BIOLOGY WAR COMMITTEE

THE Biology War Committee was formed more than two years ago with the object of establishing a clearing-house through which ideas or knowledge relating to war-time biological problems could be exchanged between biologists and the Government. In order to ensure the closest liaison and co-operation, the Committee was linked to a special Joint Committee of the Department of Scientific and Industrial Research, the Medical Research Council, and the Agricultural Research Council. Moreover, it was agreed that while the Biology War Committee should cover the main fields of biology, medicine should be excluded and that representation should be weighted in favour of those fields which were not highly specialized and in which workers were not already closely linked with the three Government research councils.

In the exploratory period following on its initiation, the Committee was concerned in organizing and also establishing contacts with both Government Departments and biologists. Attention was also given to discovering the types of biological problems most likely to arise under conditions of war.

During the last two years memoranda and reports on a variety of problems have been prepared, some at the request of the Joint Government Committee and many on the Committee's own initiative. In addition, many other suggestions, inquiries and problems have been considered. The Committee is not, however, in the position to make public any summary of its activities to date since, on the grounds of the national interest, the Joint Government Committee considers that references to specific problems would be inadvisable. The Biology War Committee can, therefore, only state that the range of problems touched on or investigated is remarkably wide. In several instances the solution has required collaboration not only between biologists of varied interests but also with other scientific workers. In fact the complexity of some biological problems, where only one link in the chain of causation may be concerned with living organisms, has obscured to non-biologists the realization that some war-time problems are in part biological. Again, lack of detailed knowledge has caused some confusion in assessing biological problems—for example, the tendency to group into broad categories and therefore a failure to distinguish between allied noxious and innocuous species.

When the original Committee, set up jointly by the Association of Applied Biologists, the British Ecological Society and the Society for Experimental Biology discussed the formation of the Biological War Committee with the Joint Government Committee, it was felt that the future Committee's usefulness would be enhanced if the composition was based solely on representation by subjects. The experience gained over the last two years has fully confirmed this view. At the same time, the Biology War Committee has been considering how best to ensure flexibility under the changing conditions of the War, and the need for maintaining close contact with biological societies.

With these ends in view, the Committee has been reviewing both its organization and its constitution. It has been decided that, as hitherto, much of the work can best be carried out by a small executive committee working in conjunction with sub-committees set up to deal with specific problems and with powers to co-opt members outside the Committee.

It has also been agreed that the membership of the full Committee should be reviewed annually and that before the final list of proposed members is settled, the list for the ensuing year should first be circulated to biological societies asking for their comments and suggestions as to the representation of subjects. In addition, it has also been resolved that two members of the executive committee, which includes the officers, should retire annually, and that only one member should be eligible for re-election. For the offices of chairman and vice-chairman, it has been decided that the tenure should not exceed one year, but that the secretary and treasurer should serve for three consecutive years.

After consultation with biological societies, the composition of the Biology War Committee for the ensuing twelve months is as follows: A. L. Bacharach; F. C. Bawden, Rothamsted Experimental Station, Harpenden; G. E. Blackman (*secretary*), Department of Botany, Imperial College of Science and Technology, London, S.W.7; Prof. P. A. Buxton*, Department of Medical Entomology, London School of Hygiene and Tropical Medicine; Prof. H. G. Champion (*vice-chairman*), Imperial Forestry Institute, Oxford; Prof. A. C. Chibnall, Department of Biochemistry, Cambridge; C. Elton, Bureau of Animal Population, Oxford; Prof. H. Munro Fox, Department of Zoology, Bedford College, London; Dr. W. P. K. Findlay, Forest Products Research Laboratory, Princes Risborough; Dr. H. Godwin*, Botany School, Cambridge; Dr. J. Hammond (*treasurer*), Animal Nutrition Research Institute, Cambridge; Prof. A. C. Hardy, Department of Natural History, Aberdeen; Dr. H. Martin*, Long Ashton Research Station, Bristol; Dr. K. Mather, John Innes Horticultural Institution, Merton, London; Dr. A. T. R. Mattick, National Institute for Research in Dairying, Shinfield, Nr. Reading; Prof. J. W. Munro, Department of Zoology and Applied Entomology, Imperial College of Science and Technology, S.W.7; Dr. J. Needham, Department of Biochemistry, Cambridge; Dr. F. C. Pantin* (*chairman*), Department of Zoology, Cambridge; Dr.

* Members of the Executive Committee.

O. W. Richards, Department of Zoology and Applied Entomology, Imperial College of Science and Technology, S.W.7; Dr. M. A. H. Tincker, The Laboratories, Royal Horticultural Society, Wisley; Prof. T. Wallace, Long Ashton Research Station, Bristol; Dr. E. B. Worthington, Freshwater Biological Association's Laboratory, Wray Castle; J. Z. Young, Department of Zoology, Oxford.

# OBITUARIES

## Prof. J. H. Priestley

PROF. JOSEPH HUBERT PRIESTLEY died at Leeds on October 31 at the age of sixty-one. He was born at Tewkesbury in 1883 and educated at Tewkesbury Grammar School (of which his father was headmaster) and at University College, Bristol. He was a graduate of the University of London and, in 1905, took charge of the Department of Botany at Bristol. In 1911 he succeeded V. H. Blackman as professor of botany in the University of Leeds. On the outbreak of war in 1914, he was in command of the University Officers' Training Corps and, as a captain, went to France with the B.E.F. During 1915–19 he served on the Staff (Intelligence), being twice mentioned in dispatches and awarded the Distinguished Service Order. In 1919 he became a Chevalier of the Crown of Belgium. After his return to Leeds, he built up a large and active botanical department there. He was a fellow of the Linnean Society and president of Section K (Botany) at the British Association meeting at York in 1932. He had for long served on the Forestry Commission, and also took a very great interest in the work of local naturalists, particularly of the Yorkshire Naturalists' Union, of which he was president in 1925.

Priestley was a man of such extreme vigour that it is not easy to give a balanced account of his activities. Quite apart from his service as a staff officer, he left his mark in each of three fields, as an administrator, as a teacher and as a botanist. To some extent, his work in each of these fields suffered from his continued and intense interest in the others, but the wider range of accomplishment was characteristic of the man.

At the time of his death, Priestley was the senior professor at Leeds, had long been a member of the Finance Committee and had served as pro-vice-chancellor for some four and a half years. His opinion on any matter of university administration was worthy of his long experience and profound interest. He had an almost equally long acquaintance with the work of the Joint Matriculation Board, of which he served as chairman; and as the head of a large department he could have had few, if any, equals. His powerful administrative judgment was based on mastery of detail, on great practical capacity and on a profound appreciation of the mentality of his fellow-men.

His botanical work started with the investigation, with F. L. Usher, of the role of the pigments in photosynthesis and the attempt to study their action *in vitro*. He was, however, chiefly interested in problems of growth, and, coming under the philosophical influence of W. H. Lang, became with characteristic enthusiasm a keen student of developmental morphology and anatomy. His preoccupation was with the organism as a living entity, and his studies of cell wall structures were intended to emphasize the view that the composition of these structures reflects the growth activities of the cells that formed them. With his great practical gifts, it was natural that Priestley should also be interested in the practical bearing of his scientific work, and he devoted much time to subjects like the influence of electricity on field crops, the propagation of plants by cuttings (Master's Lecture to the Royal Horticultural Society, 1925) and, finally, spiral grain in timber. His later work focused attention particularly on the properties of growing cells and tissues, on development in monocotyledons and on cambial activity in trees. The purpose of his work was to show that the form and structure of an organ reflects the "organisation of growth" in the tissue which formed it.

No doubt views will differ on the question of whether Priestley's success as a teacher was greater or less than that as an investigator. He was certainly a born teacher and the impact on his students of his powerful and vigorous personality was tremendous. Those who were going to teach science must have profited enormously by acquaintance with his methods, which always focused attention upon the fundamentals of the subject under review. The gift for seizing the main point at issue was certainly an outstanding feature of Priestley's character and it ran through all his work, administrative, educational and scientific. Combined as it was with never-failing courage, boyish enthusiasm and outstanding vigour, it made him sometimes didactic, often provocative, always interesting and, as a whole, one of the most colourful persons in biology.

W. H. PEARSALL.

IN the death of Prof. J. H. Priestley the botanical world and the Department of Botany of the University of Leeds have lost a man of originality and genius. Though cut off from fulfilling the period of university service to the usual age of retirement, his life has been a full one, and the record of his achievements is one of which any man might be proud.

As an undergraduate at Bristol, though primarily a student of botany, Priestley also attended the honours courses in chemistry and physics, a training which gave him an exceptionally sound basis upon which to found his botanical studies. At the close of his studentship, at the early age of twenty-two, his gift for leadership was recognized and he was deemed worthy to take charge of the Department of Botany in University College, Bristol. Coming into botanical science at a time when many botanists had been absorbed in confirming and amplifying the great discoveries of the late nineteenth century, he brought to botany an alert mind and a fresh outlook, which undoubtedly owed much to his sound knowledge of the pure sciences. One of his first lines of investigation was an attempt to ascertain the first product of photosynthesis, but later his interests turned more and more towards developmental and causal studies; in this new line of attack on plant problems he often turned for advice and encouragement to Prof. W. H. Lang, of Manchester, of whose work and judgment he held a very high opinion. The results of his studies along these original lines, with the complementary teleological work of Haberlandt and his school, gave to botany a much more satisfying understanding of many plant structures. His last and most outstanding phase of research dealt with problems of tree growth; he was much absorbed in the dynamic problems of

cambial activity and vessel differentiation, and his connexion with the Forestry Commission gave him opportunities to apply his knowledge to problems of afforestation.

Priestley had an exceptional knowledge of the literature and a memory for recorded detail with a capacity to fit together such scattered pieces to give a picture of his problem as a whole, where each detail fell into its right place and assumed its right value. He was himself often the first to admit that suggested interpretations of certain new lines of investigation had found their way into print prematurely, but even in such cases the interest aroused stimulated such vigorous work on the subject in question, to prove or disprove his theories, that botanical science had much to gain. The recorded facts upon which his theories were based were always sound.

Throughout his long service to science, perhaps his outstanding merits, which will long outlive him in the work of his students, have been the inspiration for research, the importance he placed upon true recording of facts and soundly based and courageous attempts to interpret them. In his teaching he maintained a freshness of outlook by the continual introduction of new methods and facts, which, from his great fund of knowledge, he selected to illumine aspects of subjects which students previously thought they had fully assimilated.

L. I. SCOTT.
R. D. PRESTON.

## Dr. Thomas Swinden

THE death of Dr. Thomas Swinden on October 27 at the age of only fifty-eight has deprived the steel industry of one of its ablest leaders, who during the past year had been playing an important part in the reorganization of research in iron and steel, and whose further help in that field would have been invaluable.

Dr. Swinden was born in Sheffield on August 15, 1886, and studied in the University of that city, being Mappin Medallist in 1905. During 1906–8 he held an 1851 Exhibition Scholarship, studying metallurgy at Stockholm and Uppsala. During 1909–13 he worked as a Carnegie Research Scholar, and was awarded the Carnegie Gold Medal. In 1913 he also obtained the degree of D.Met.

From 1909 Dr. Swinden was chief metallurgist to Samuel Fox and Co. of Stocksbridge, and was later works manager and director, but in 1932 he took up the important post of director of research in the United Steel Companies, Ltd., of which Samuel Fox had become an associate company. In this capacity he built up a remarkable research organization, with an able staff and well-equipped laboratories. Many valuable contributions have been made from this centre, both to metallurgy proper and to the study of refractory materials.

Besides controlling and guiding the research work of a large industrial concern and directing its application in practice, Dr. Swinden interested himself from the beginning in co-operative research for the whole of the iron and steel industry, and was one of the most active members of the committees and sub-committees set up jointly by the Iron and Steel Institute and the Iron and Steel Federation. Within the last few months he had assumed the chairmanship of several of these in succession to the late Dr. W. H. Hatfield, and he was an indefatigable worker for those committees. As a member of the Council of the British Iron and Steel Research Association which has recently been formed to take control of this work, he would have had many responsibilities in this field. During the War he took a leading part in the work of the Technical Advisory Committee on Alloy Steels, and was a member of the metallurgical mission to the United States in 1943, which imposed a considerable strain on those who took part in it.

Swinden's early papers dealt with the constitution and properties of the tungsten and molybdenum steels, and came at a time when there was very little information on such complex alloy systems. Later, he was responsible for much of the progress made in the production and use of steels with controlled grain size, and in recent years he and his collaborators did excellent work on the relations between carbon, oxygen and nitrogen in steel, making many improvements in the methods for estimating those elements, and making a special study of the low-carbon steels of the 'rimming' type.

Swinden was the most pleasant and courteous of colleagues. Very modest himself, he always gave full credit to his fellow-workers in his published work. His judgment on any disputed point was invariably trusted, on account of his wide practical experience and sound scientific knowledge. He was a faithful member of the Iron and Steel Institute, of which he had recently become a vice-president. He had received its Bessemer Gold Medal in 1941, as well as medals from the North East Coast Institution of Engineers and Shipbuilders and the Institution of Marine Engineers.

Always a hard worker, Dr. Swinden was found to be suffering from overstrain in the spring of this year and was compelled to take a rest. He had, however, apparently made a good recovery and had resumed much of his work, so his sudden death came as a shock. He had a happy married life, and leaves a widow and two sons to mourn his loss.

C. H. DESCH.

## Dr. Paul Ostern

DR. PAUL OSTERN was killed by the Nazis in Lwow at the beginning of July 1941, during a pogrom in which several men of science, scholars, physicians and others died. Ostern is well known to biochemists all over the world: although young, he made brilliant contributions to biochemistry. Born in Zloczow in 1902, he studied medicine in Lwow, and joined my staff in 1927. Ostern was especially gifted for chemical work. Though he received no special chemical training, except in my biochemical laboratory, he was able to cope with the most difficult chemical investigations. It was he who succeeded in obtaining on a large scale not only inosinic acid from muscle but also adenylic acid: during the nineteen-thirties every laboratory which was using adenylic acid for research purposes acquired it, directly or indirectly, from the Laokoon factory in Lwow, where Ostern was collaborating, and where the preparation of adenylic acid from fresh meat was under his supervision. Only in 1937 this changed, when Ostern made his brilliant discovery of enzymatic synthesis of adenylic acid from adenosin and phosphate, the method now generally employed for the production of adenylic acid—also for therapeutic purposes.

After his first research work concerning the formation of ammonia in the heart and the transformations of adenylic acid in this tissue, Ostern spent some time abroad, where his work with Krebs in Freiburg

was interrupted by the Nazi seizure of power and Krebs leaving that country; with Verzar in Basel, and then with Krebs again, in Cambridge. In Lwow he participated in the team work, with myself and Dr. T. Mann, now in Cambridge, which led to the discovery of direct enzymatic transfer of the phosphate group from phosphoglyceric to adenylic acid, with the formation of adenosintriphosphoric acid, and to the chart of the linkage of chemical transformation in glycogenolysis, as now generally accepted. With T. Baranowski and J. Reis (now in the British Eighth Army), Ostern discovered (1935) the direct transfer of phosphate from adenosintriphosphoric acid to creatine, and the role of the phosphocreatine-creatine system as an alternating acceptor and donor of phosphate was disclosed; in 1936 he discovered that Harden-Young fructose-diphosphate is formed from the monoesters and adenosintriphosphoric acid, and this very important link in glycogenolysis and glycolysis, the inhibition of which by oxidizing agents, as recently found by Engelhardt, is the essential factor of the Pasteur effect, was discovered by Ostern and his associates. His last important discovery was made, with E. Holmes and D. Herbert, in 1939, during a short stay in Cambridge—that glucose is formed in the liver by way of phosphorolysis of glycogen and subsequent hydrolysis of the phosphoric ester. The formation of glycogen from the Cori ester by liver enzymes was then published by these workers, simultaneously with the St. Louis group.

In 1940 Ostern was appointed professor of organic chemistry in the Medical School in Lwow. Unfortunately, he did not leave the city when the Germans approached. His many friends abroad will deeply regret the untimely death of this outstanding scientific worker. J. K. PARNAS.

## Prof. Forsyth James Wilson

PROF. F. J. WILSON, Freeland professor of chemistry in the Royal Technical College, Glasgow, died suddenly on October 18. For the long period of thirty-eight years he had been associated with the College which he served faithfully and well; his first appointment was that of chief assistant to Prof. G. G. Henderson. During the period 1914–19 he served in the Army, ultimately as chemical adviser to the Eleventh Army Corps. On more than one occasion he was mentioned in dispatches.

In 1919 Wilson returned to the College to fill the chair of inorganic and analytical chemistry. On the transfer of Prof. I. M. Heilbron to the University of Liverpool, he succeeded, at his own request, to the chair of organic chemistry, and held that until the death of Prof. R. M. Caven, when the two chairs were amalgamated in the Freeland Chair. This is good evidence of his breadth of knowledge of the subject.

Born at Moffat in 1880, Dr. Wilson received his earlier training at the University of Edinburgh, from which he passed after a distinguished record to Leipzig, being associated there with Hantsch and Stobbe. On returning to Great Britain he joined Prof. A. G. Green at Leeds in research on dyestuffs.

In Glasgow, he took a lively interest in all the local sections of the various chemical societies and at different intervals acted as chairman. He was meticulous in his attendance at meetings, and his general bearing in discussion was always courteous. In due course he served on the councils of the Chemical Society and the Royal Institute of Chemistry, and held office for more than one period in each case. Nearest to his heart was perhaps the British Association, and he rarely missed a meeting of the Chemistry Section.

In the limited time available from heavy official and teaching duties, Wilson was actively engaged on research in organic chemistry, collaborating with many colleagues, among them Stobbe, Boon, Heilbron, and more recently with members of the present staff of the College, Sutherland, Hopper, Crawford, McLean, and others. His research work was mainly devoted to a study of stereoisomerism with special reference to derivatives of semicarbazide and thiosemicarbazide, and to the resolution of optically active compounds derived therefrom. Latterly, he developed a special interest in certain aspects of chemotherapy, and in this connexion was associated with Imperial Chemical Industries Ltd. He was a frequent contributor to the *Journal of the Chemical Society*. With Prof. Heilbron he published a very useful little book on "Chemical Theory and Calculations"; although now out of print, it earned well-deserved popularity among a wide circle of students some twenty years ago.

Wilson's work in and for the Royal Technical College, Glasgow, met with unqualified approval and success, and his influence upon his students as well as his personal relations with them were admirable. Many of them holding important positions throughout the world will recall with pleasure his warm personal interest in their well-being, both during and after college days. Of shy and retiring disposition, he was a man of considerable grace and charm, highly respected and esteemed by his colleagues, no less than by his students. W. M. CUMMING.

## Dr. Henry J. S. Sand

DR. HENRY J. S. SAND died, after a short illness, at Nottingham on October 18. He will be remembered as an electrochemist of international repute, and he had also published outstanding original work in other branches of chemistry.

Dr. Sand was born in Dundee on December 7, 1873. He received his early education at the High School, Dundee, and later at the Realgymnasium in Dresden. It was during these early years in Germany that the foundations were laid of his excellent knowledge of the German language. For a short time he studied under Hempel at the Dresden Polytechnic, and then continued his university career at Zurich, where his inaugural dissertation was published in 1898. Here he worked under Bamberger, studying organic chemistry, and was awarded the degree of Ph.D. Upon his return to England, Dr. Sand worked with Ramsay at University College, London, for a short period and then, as a holder of a Bowen Research Scholarship at the University of Birmingham during 1899–1901, commenced the studies in electrochemistry for which he is so well known.

In 1901 Dr. Sand took up the post of lecturer and demonstrator under Prof. Kipping at University College, Nottingham, and continued his researches. He was awarded the degree of D.Sc. at Birmingham in 1905. In 1914 he moved to London and held the post of senior lecturer in chemistry at the Sir John Cass Technical Institute, London, until 1921, after which date until he retired in 1938 he was head of the Department of Inorganic and Physical Chemistry.

Sand's published scientific work is contained in about fifty original papers with subjects varying in scope from laboratory apparatus of his own design and construction to theoretical discussions in thermodynamics. He was thus both an able and skilled experimenter and a thinker of wide scientific outlook. Outstanding among his original investigations are the work on electrode processes including diffusion at electrodes and over-voltage, the development of vacuum-tight seals for leading in wires to silica and glass vessels, and various improved methods of electrochemical analysis. Particularly among these should be mentioned the separation of metals by control of electrode potential and the use of 'internal' electrolysis for determination of metallic elements in the presence of larger quantities of less noble metals. In 1939, 1940 and 1941 there were published successively the three volumes of his "Electrochemistry and Electrochemical Analysis", a work upon which he had spent many years of thought and labour and which summarized the state of electrochemical knowledge to that date.

To those who had the privilege of knowing him, Dr. Sand was a most amiable man. His former colleagues and research students particularly will remember his tolerant and kindly criticism, his balanced judgment and his unfailing help, which he gave freely to all those who brought their problems before him. He will be remembered and missed by many friends all over the world, and they will think with sympathy of his widow, and his only son who is now serving with the British Army overseas.

ARTHUR J. LINDSEY.

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WE regret to announce the following deaths:

Sir Joseph Arkwright, F.R.S., honorary bacteriologist at the Lister Institute, on November 22, aged eighty years.

Prof. Charles F. Park, emeritus professor of mechanical engineering at the Massachusetts Institute of Technology, director of the Lowell Institute School, on September 25, aged seventy-five years.

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# NEWS and VIEWS

## *The Times* and Freedom of the Press

How often do readers notice the serial number at the front of a journal? Yet this number is much more than a convenient means of identification used by publishers and printers; as is pointed out in an article in *The Times* of November 25, it indicates the intention of continuing to produce the journal at short intervals, so that the reader can follow the progress of events—it is a sign of continuous and watchful activity. *The Times* has given this service to Great Britain for the past century and a half, and it has now proudly inscribed the number 50,000 on the front page of its issue of November 25. As the years have gone by, *The Times* has grown in stature, under a succession of distinguished editors, until it is now an organ of international repute.

The leading article of the 50,000th issue rightly ends on the note of the freedom of the Press. One of the first acts of an authoritarian regime is to suppress the expression of contrary views; government by consent of the people, the very essence of democracy, requires a free Press, able to reflect and to guide public opinion. In times of war, a democracy must accept, however grudgingly, a considerable measure of dictation, including censorship of the Press. This suppression of facts in the interests of national security is an evil necessity under which every member of a democracy must chafe; particularly is this restriction of publication felt in scientific circles, where the free interchange of news and views is the life-blood of progress. *The Times*, with other journals, has accepted the necessity of censorship, but it declares in no uncertain terms its policy for the future: "As the war draws to an end and the shadow of military necessity recedes, the immediate task will be to ensure that every encroachment of authority shall be rolled back from a field of responsibility in which, in a free community, it can have no place". It will have the support of all who value democracy in carrying out this policy in the years to come.

## Communities and Industry

THE broadsheet "Location of Employment" issued by Political and Economic Planning is a timely contribution to the discussion of the fundamental questions in town and country planning on which early decisions must now be taken by the Government. The broadsheet attempts first to analyse the employment needs which are relevant to physical planning, and then considers how far those needs could be met on the scale of a community comprising not more than about 60,000 people. The conclusion is reached that a satisfactory variety of industry and occupation can usually only be provided for a group of communities, and not, as town-planners have often suggested, for each community separately. The important concept is not so much that of the community as that of the employment orbit, or the area in which any point can be reached within reasonable daily travelling time by the members of the community. For some communities it may be far better to improve communications with other places than to try to bring industry within the borders of the community. It should be possible for the majority of wage-earners to find work fairly near to their homes; many jobs in secondary and tertiary industries can be located in the community itself, and the broadsheet points out that the employment exchanges, by the use of judicious and flexible placing methods, can help in this. Secondly, the time taken up in travelling to work can be cut down by improving transport and by careful layout and correlation of the several communities.

Even when communities have been grouped in this way for purposes of employment, there may still be some which have no economic future by themselves and are so isolated that they cannot be combined in a larger region. Such communities, *Planning* considers, should be closed down. Again, the employment orbits suggested may not be suitable units for the industrialist. The advantages he requires may not always be provided therein; but it should be

possible to provide them in a region containing a number of such orbits. If there is movement of population from the congested cities, the 'overspill' is likely to be better accommodated and better employed if it is kept in close relation to a regional or sub-regional centre than if it is dispersed to independent new towns. Industrial development should be viewed on a regional scale, taking fully into account the existence of the traditional regions, and aiming at introducing new complexes of industry into these existing regions. The broadsheet points to several factors which increase the mobility of industry, but finally emphasizes the difficulty of applying the general principles indicated. Usually, in practice, the decision must be a balance between economic and social considerations, and close co-operation between the central Government and industrialists is needed.

### Selection of Medical Students

IN an earlier issue (*Nature*, **154**, 315, Sept. 9, 1944) the possibility that intelligence tests might be used as aids in the selection of candidates who wish to undergo a medical training was discussed in relation to the proposals of the Goodenough Committee on Medical Schools and the Planning Committee of the Royal College of Physicians for the selection of medical students by personal interview rather than by examinations alone. Drs. O. G. Edholm and Q. H. Gibson (*The Lancet*, 294, Aug. 26, 1944) have now published the results of their work on examination results as intelligence tests. This work was done at Queen's University, Belfast, where second-year medical students have, for the past three years, carried out "an intelligence test, using Raven's Progressive Matrices" (J. C. Raven, Progressive Matrices, London, 1938). The scores obtained were compared with examination results. The students included 20 per cent women, and the average age of both men and women students was 19½ years. These authors conclude that "one of the most striking and important points which emerges from these results is the high mental ability of the average medical student, as measured by the matrix test". They quote the report of the Planning Committee of the Royal College of Physicians as saying that the average medical student of to-day is lacking in initiative and curiosity, with poor ability to arrange and interpret facts and little precision in the use of words. "If we accept this statement," these authors comment, "either unusually great ability is necessary to avoid these faults, or they are not primarily due to any lack of intelligence." Other critics of the mental ability of the average medical student might take this statement to heart.

More pertinent to the selection of future medical students is the conclusion of Drs. Edholm and Gibson that "a fairly rigid process of selection has already been applied by the time the student reaches his second year". This would seem to confirm the view expressed in *Nature* (*loc. cit.*) that "Selection can . . . be imposed too early, and the value of the natural selection of the medical school and the hospital can be underestimated". Discussing the question whether the matrix test would be valuable for the selection of medical students, these authors conclude that the results of previous examinations form a more reliable index of results in future ones. They find no reason to think that the medical students of Queen's University are not representative of the intelligence of medical students generally; but they think that further work should be done to show whether their results are generally applicable. R. G. Inkster (*Roy. Acad. Med., Ireland*, Sect. Anat. and Physiol., March Meeting, 1944) obtained results similar to theirs; but he used an entirely different intelligence test. The authors do not wish to imply, however, that success in examinations is the only criterion of the satisfactory student.

### Spectrographic Discussion Group

THE Spectrographic Discussion Group was formed in 1941 as a result of approaches made to the various users of spectrographic equipment in the Glasgow area. It was considered that, in view of the extent to which industrial concerns and Government departments were applying spectrographic methods of analysis and the very rapid developments which were taking place in this branch of science, it would be of value if those directly interested in spectrography were able to meet at intervals and discuss the various problems which arose in the course of their work. Further, it was considered advisable that representatives of the principal technical institutions and of manufacturers of spectrographic equipment should have the opportunity to attend these discussions. The fundamental policy of the Group required the free interchange of ideas and co-operation in tackling any problems which arose as a result of discussion. Although originally confined to members in the Glasgow area, the success of the Group was such that, in a relatively short time, members representing concerns in Aberdeen, Sheffield, London and other parts of the country were admitted. Meetings of the Group are held in the Royal Technical College, Glasgow, at intervals of approximately six weeks. The chairman is Mr. S. D. Steele, of Babcock and Wilcox, Ltd., Renfrew, Scotland. It has always been considered of first importance that the nature of these discussions be informal, and that in no sense should the Group acquire the character of a society. In this respect it has been found necessary to limit membership to those directly interested in spectrography and also to control membership by invitation. The success of the Group and the progress made have been so marked that it is felt that groups of a similar nature established throughout Britain would be most beneficial.

### Long Ashton Research Station

THE annual report of the Long Ashton Research Station for 1943 has now been published. Several important changes in senior staff appointments mark the period covered, for Prof. B. T. P. Barker, director of the Station during its first forty years, has retired, being succeeded by Prof. T. Wallace, while Mr. A. W. Ling, though still remaining chief agricultural advisory officer in the Bristol Province, has been appointed principal of the Seale Hayne Agricultural College, Devon. The research work undertaken during the year continued to be closely concerned with current problems of the food production programme of the Ministry of Agriculture, and many useful results were obtained, only a few of which can be mentioned here. Tests made with apples, swedes, carrots and potatoes showed that ½–1 per cent naphthalene-acetic acid exerts a delaying action on bud-growth, a fact which should prove of practical importance in preventing sprouting of stored potatoes, while an allied compound, naphthoxyacetic acid, sprayed at the rate of twenty parts per million, had a stimulating effect and increased the yield of Tardive de Leopold strawberries. Outstanding results have

been obtained with dichlor-diphenyl-trichlorethane (D.D.T.) as an insecticide, and the compound seems to merit field trial as a substitute for lead arsenate. Records of mineral-deficiency responses in plants have been extended, and symptoms for twenty-three new crops added to the list. As regards advisory work, a total of 10,880 letters were dispatched and forty-three papers published in scientific journals by members of the Long Ashton, Berkeley Square and Campden staffs.

## Indian Woods for Textile and Jute Mill Accessories

IN *Indian Forest Bulletins* Nos. 121 and 122 (1943) (Forest Research Laboratory, Dehra Dun) substitutes are proposed for imported cotton mill shuttles, bobbins, etc. In Bulletin No. 121, by M. A. Rehman, the results of tests carried out at the Research Institute, Dehra Dun, on the suitability of Indian timbers for cotton mill shuttles for power looms, to replace cornel and persimmon ones imported from America, are described. A large number of timbers considered suitable for their known characteristics were tested. After elimination, the seasoned and selected blanks of woods which appeared promising were sent out for manufacturing trials. The finished shuttles were then tested in weaving mills under factory conditions. Results have shown that the light-coloured sapwood of *Diospyros melanoxylon* or ebony is the best Indian timber so far tested for shuttles. It gives about 50 per cent of the life of imported timber. Other species mentioned in the Bulletin are being used in parts of India where the particular timbers are more easily obtainable.

Bulletin No. 122, by M. A. Rehman and Chheda Lal, treats of the care and seasoning of woods for bobbins, picker arms and jute mill rollers. Suggestions are made for using indigenous woods for the manufacture of these implements; for example, imported bobbins were of beech, birch and maple. Sixteen Indian species of woods belonging to fifteen genera growing in different provinces have been tried out. Species of four of these genera are used extensively throughout the country for bobbin-making. Their life does not appear to be much more than 30 per cent of the imported bobbins. Picker arms and jute mill rollers are also discussed.

## Forests of Trinidad

THE present position of forestry in Trinidad (Trinidad and Tobago, Forest Dept. Admin. Report for Year 1943. Trinidad and Tobago: Govt. Printer) appears to be of considerable interest. There are not many British Colonies which can state that the general position with regard to forest reservation is eminently satisfactory, and that the forest reserves occupy 22·7 of the total area of the Colony "after deducting the area leased to the U.S.A."; and further, that "almost all the forest reserves are now governed by Working Plans under which some form of elementary yield control has been introduced". This is, or should be, the first object in management to be aimed at by the trained forest officer; but, whatever the reasons, it has been neglected in most of the forest regions under the Colonial Office. As elsewhere in the British Empire, the bar-restrictions in timber imports have resulted in the demand for unseasoned local timber exceeding the supply. This being the case, it is difficult to follow the argument that high costs (these prevail everywhere), low volume production per acre (common to the tropical mixed forest generally), and high loss in conversion of tropical woods make it doubtful whether any such supply from the natural mixed forests could in normal times compete with imports. The exploitation of the more or less gregarious *Mora* forests has been under consideration for years; it is now said that there is a high conversion loss owing to the refractory nature of *Mora* as a timber. It would appear that there is now an unexpected chance to introduce, as has always been the case in most parts of India, the indigenous Trinidad timbers to the population in such a manner as to render their use a permanency in the Colony. There is no mention in the report of a recognition of the advantages offered to the type of forests existing in Trinidad by the introduction of a plywood mill.

## British Astronomical Association

A BROCHURE entitled "The British Astronomical Association. Its Nature, Aims and Methods" has been issued by the Association with the main object of encouraging amateurs to undertake astronomical work. Fourteen sections are now in existence, and valuable work is still being done in spite of the difficulties of war conditions. Novices need not be deterred even if they have very little instrumental equipment; in some cases, such as the observation of meteors, auroras, zodiacal light and in historical research, etc., no equipment of any kind is necessary. Proof of the important work that amateurs can do is afforded by a recent triumph of the Computing Section under Mr. J. G. Porter; with the help of four members of this Section, a definitive orbit of Comet Pons-Winnecke has just been computed (*J. Brit. Astro. Assoc.*, 54, 7; 1944). This is probably the first time in the history of astronomy that a body of amateurs has computed a definitive orbit, and it is a testimony to their wonderful patience and skill in handling figures that this formidable work has been accomplished.

Fifty-four years of work by members of the Association have seen much accomplished and also an increasing interest in astronomy. The membership has had a remarkable growth within the last few years and now exceeds 1,200. During the War, the Association moved its meeting place and library to the premises of the Royal Astronomical Society, Burlington House, Piccadilly. Information regarding conditions of membership, etc., should be addressed to the secretary at the above address. Mr. F. J. Hargreaves retired from the presidency in October and the new president is Mr. P. J. Melotte, of the Royal Observatory, Greenwich.

## Public Health in Turkey

THE *Asiatic Review* of October contains an interesting article by Bay Nuzhet Baba on the public health effort and social assistance in Turkey. The central authority in charge of health and social assistance is the Ministry of Health and Social Assistance. Free treatment of the sick, campaigns against epidemics and diseases, especially malaria, trachoma, typhoid fever and dysentery, all fall within the sphere of activity of the Ministry. To the Ministry also are entrusted the supervision of maternity homes, hospitals and sanatoria. In order to emphasize the importance of medical examination of school children, dental care, vaccination against small-pox, inoculations, etc., the Ministry has drawn up regulations whereby municipalities are obliged to provide such

services free of charge. Museums have been established and exhibitions arranged to propagate hygienic principles, and posters and pamphlets are distributed to the villages and displayed in public places.

## Insect Pests of Food

The Ministry of Food has published, under the title of "Insect Pests of Food" (London: H.M. Stationery Office, 5*s*. net), two important papers on moths and their larvæ affecting stored products. They are designed to provide a reliable and up-to-date guide to the identification of the insects referred to. Although the two papers are primarily for the use of the Ministry's inspectors, they will be valuable to anyone concerned with the pests in question. The paper on lepidopterous larvæ affecting stored products is by Dr. H. E. Hinton and was originally published in the *Bulletin of Entomological Research* (**34**), and that on the moths by Dr. A. S. Corbett and Mr. W. H. T. Tams is reprinted from the *Proceedings of the Zoological Society of London* (**113 B**).

## Domestic Electrical Accessories

The design and installation of electrical accessories for domestic purposes was dealt with in a paper read by F. C. Fuke in London recently before the Institution of Electrical Engineers. The paper states the requirements which the design of electrical accessories must fulfil and how such requirements can be met. Contacts and switching are dealt with at some length, because of their effect upon the performance and life of most accessories. The fundamentals of fuse design are given, as well as the reason for possible indiscriminate operation between fuses of different types. The need to break away from some time-honoured practices is shown, with particular reference to plugs and tumbler switches, and solutions based on theoretical and practical considerations are presented. The author considers that British Standard Specifications should be confined to setting standards of performance, with interchangeability only where required, and that constructional details and dimensions should be omitted so as to give maximum freedom for development and, therefore, progress in design.

## Botanical Periodicals at Oxford

A catalogue of interest and value to all research workers and teachers in botany who wish to consult out-of-the-way journals as well as those more easily obtained has just appeared in the "List of Periodicals" issued by the Library of the Botany Department at Oxford. The purpose of the Library is, of course, to serve in the first place the needs of the Department, and this list was naturally prepared to that end; it is, however, now available for limited circulation. It is obvious that the privilege of borrowing books for use outside Oxford can only be granted in exceptional cases and through recognized channels; but the list will undoubtedly be of assistance to those in need of periodicals otherwise obtainable only with great difficulty and to whom these channels are available. The list is clearly annotated, the information being obtained chiefly from the periodicals themselves, and a useful feature is that all journals with current numbers in the Library are printed in bold type.

## Recent Earthquakes

The United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has determined the provisional epicentres of five recent earthquakes. The first, on August 7, at 3h. 25·3m. G.M.T., had its epicentre at 16·9° S., 71·5° W., which is in Peru. The second, on August 10, at 1h. 52·7m. G.M.T., had its epicentre at 51·4° N., 130·5° W., which is south of Queen Charlotte Islands, off British Columbia. The third, on August 18, at 10h. 33·1m. G.M.T., had its epicentre at 35° N., 137° E., which is in Japan. The depth of focus of this shock was probably near 200 km. The fourth shock occurred on August 24 at 23h. 37·8m. G.M.T., and had its epicentre at 15° N., 93° W., which is in Guatemala. The depth of focus of this shock was slightly less than 100 km. The fifth earthquake occurred on September 5 at 4h. 38·8m. G.M.T. It had its epicentre at 45° 01′ N., 74° 44′ W.

On October 6, at about 5.30 a.m. local time, an earthquake in Anatolia, south of the Dardanelles and near the ruins of Troy, is reported to have destroyed 4,000 buildings in Ayvalik, Edremit, and the surrounding district, and to have caused the deaths of 44 persons; 112 others are reported injured as a result of the earthquake. Further news of this shock is awaited.

## Announcements

Sir Fred Clarke, director of the Institute of Education and professor of education in the University of London, will retire under the age limit on September 30, 1945, and the University has appointed Prof. G. B. Jeffery, Astor professor of mathematics at University College since 1924, to succeed him in the post of director of the Institute.

Brigadier George Macdonald, assistant director since 1939 of the Ross Institute of Tropical Hygiene, London School of Hygiene and Tropical Medicine, has been appointed director of the Institute and will take up his appointment on release from the Services.

Dr. A. G. Sanders has been appointed medical adviser in China to the British Council and has arrived in Chungking. Dr. Sanders is one of the group of Oxford workers, led by Sir Howard Florey, who developed and extended Sir Alexander Fleming's earlier work on penicillin. He was chiefly responsible for the design and construction of the apparatus used for large-scale laboratory production of penicillin. The primary object of his visit is to investigate and organize the exchange of information between China and Britain on matters of importance in medical science and practice; and he will be working under the direction of Dr. Joseph Needham, director of the British Council Cultural Scientific Office at Chungking.

Sir John Russell, who has for the past eleven weeks been in a nursing home where he has undergone a surgical operation, is sufficiently recovered to be able to return shortly to his home at Campsfield Wood, Woodstock, Oxfordshire.

The following appointments have recently been made by the Colonial Office: R. A. Butt, to be assistant conservator of forests, Uganda; J. D. Farquhar, to be assistant conservator of forests, Palestine; G. Watkins, to be assistant conservator of forests, Tanganyika; R. D. Hodgins, to be veterinary officer, Northern Rhodesia; R. P. Lee, to be veterinary officer, Tanganyika; H. S. Darling, plant protection officer, Palestine, to be entomologist, Uganda.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Generic and Specific Trivial Names of the Tertian and Quartan Malaria Parasites

THE "Official List of Generic Names in Zoology" was established by the International Congress of Zoology in order to promote stability in zoological nomenclature by placing on record the correct names of the principal genera in each of the classes and orders of the animal kingdom, together with their type species. Hitherto names have been placed on the "Official List" in *Opinions* rendered by the International Commission on Zoological Nomenclature, but in 1943, the International Commission decided that it was desirable to make the "Official List" more readily available, and accordingly decided to publish it as soon as possible in convenient book form and with a full index. The preparation of the "Official List" for publication in this way, which was begun in the autumn of 1943, involved the checking of all the relevant bibliographical and other references to the generic names concerned and their type species. In the course of this work, errors were detected in a number of the *Opinions* containing decisions relating to the "Official List". These errors are being brought at once to the attention of the International Commission with the view of its rendering an *Opinion* as soon as possible containing such rectifications as may be necessary.

Among the errors detected were errors in the entries in *Opinion* 104 (published in 1928) relating to the author's name and date of publication of the generic name for the malignant tertian malaria parasite (*Laverania* Feletti and Grassi, 1889). Further, in the case both of this name and of that for the quartan parasite (*Plasmodium* Marchiafava and Celli, 1885) the type species was found to have been cited under a name which was not the correct name under the International Code of Zoological Nomenclature.

The names of these parasites, as recorded in *Opinion* 104, are the names now universally employed for these species in the enormous medical and technical literature relating to malaria, and it would clearly be as wrong as it would be impracticable to attempt to introduce changes in such names merely on grounds of zoological nomenclature. In the present case such changes would be particularly undesirable, since they would involve the transfer of the specific trivial name *malariæ* from the quartan parasite (on which it was bestowed by Grassi and Feletti, 1890), by which name this species is universally known, to the malignant tertian parasite on which, in 1881, it had been independently bestowed by Laveran (and by which name this species is never called). Transfer of trivial names in this way causes great confusion, and the only solution in such a case is for the International Commission to use its plenary powers to suspend the rules in order to validate the names currently in use.

It was accordingly decided early in 1944 to invite the International Commission to deal with this question under its plenary powers, and, for this purpose, a thorough investigation into the highly complicated literature of these names was made, with the assistance of Sir Rickard Christophers and Brigadier J. Sinton, whose paper, "The Correct Name of the Malignant Tertian Malaria Parasite", published in 1938 (*Brit. Med. J.*, ii, 1130; 1938), must form the starting point of any work on this subject. In the course of this investigation, names previously overlooked were brought to light and other unsuspected nomenclatorial difficulties were disclosed. A paper setting out in detail the present position under the International Code and containing recommendations to the Commission for placing the whole matter on a satisfactory footing has been prepared and will appear in the next part of the *Bulletin of Zoological Nomenclature*, the official organ of the International Commission on Zoological Nomenclature.

Quite recently, the officer in charge of malaria control in war areas, Atlanta, Georgia, U.S.A., communicated to the International Commission an application prepared by Drs. Curtis W. Sabrosky and Robert L. Usinger, U.S. Public Health Service, directing attention to the errors in *Opinion* 104 and requesting the International Commission to use its plenary powers to suspend the rules for the purpose of validating existing nomenclatorial practice in regard to these parasites. This application has since been published in *Science* of September 1, 1944. It is extremely gratifying to the Executive Committee of the International Committee to find that malariologists in the United States, working independently, have reached substantially identical conclusions in regard to this matter, since this should greatly facilitate the early adoption by the International Commission of an *Opinion* setting this matter at rest once and for all.

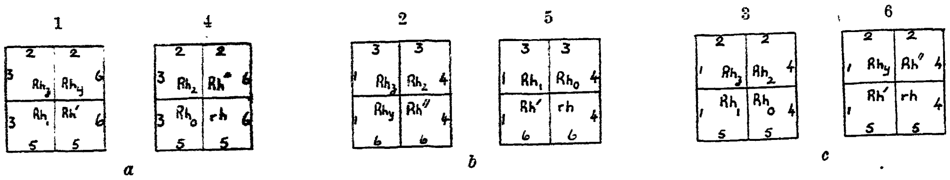
In order to secure the widest support for the action proposed to be taken, the Executive Committee, on behalf of the International Commission, invites expressions of opinion from specialists concerned in any aspect of the malaria problem. Such communications, which should be addressed to the International Commission on Zoological Nomenclature at its Publications Office, at 41 Queen's Gate, London, S.W.7, will at once be published in the Commission's official organ, the *Bulletin of Zoological Nomenclature*, in order that the whole of the material relating to this case may be before the commissioners when reaching their decision.

FRANCIS HEMMING.
Secretary,
International Commission on
Zoological Nomenclature.

## A Nomenclature of Subgroups of the *Rh* Factor

SINCE Race added two further hypothetical allelomorphs tentatively called $Rh_y$ and $Rh_z$ to the six genes recognized by Wiener[1], which had been independently discovered by Taylor and Race (namely, $Rh_1$, $Rh_2$, $Rh_0$, $Rh'$, $Rh''$ and $rh$), the terminology is somewhat confused. Recently Race[2] has described Prof. R. A. Fisher's ingenious system of three allelomorphic antigens named *Cc*, *Dd*, *Ee*, with Greek lettering for the antisera. They predict the existence of two as yet undiscovered antisera $\eta$ and $\delta$. The disadvantage of this scheme is the duplicate system of lettering.

The nomenclature now suggested is simple; it is based on the numbering of the antisera 1 to 4[3], and could easily be extended. It is proposed that the reaction of cells should be expressed in terms of the



*a* *b* *c*

sera with which they react. Its value lies chiefly in the naming of phenotypes, so that at a glance it may be seen exactly with what sera the cells have been tested. Eight genes have now been postulated, and their reactions with the four sera so far discovered can be set out as follows:

| Red cell genes | Antisera 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| | Anti $Rh_1$ | Anti $Rh_2$ | Standard | *St* |
| $Rh'$ | + | — | — | — |
| $Rhy$ | + | + | — | — |
| $Rhz$ | + | + | + | — |
| $Rh_1$ | + | — | + | — |
| $Rh''$ | — | + | — | + |
| $Rh_2$ | — | + | + | + |
| $Rh_0$ | — | — | + | + |
| $rh$ | — | — | — | + |

It will be seen that the table is completely symmetrical, and that cells which react with serum 1 fail to react with serum 4 and *vice versa*. Thus the reactions of the eight genes can be arranged as in the accompanying diagrams at (*a*).

The two undiscovered antisera of Fisher we will call 5 and 6. Thus the reactions of serum 5 and serum 6 will be related to those of serum 2 and serum 3, in the same way as serum 4 is to serum 1, and are shown as (*b*) and (*c*) in the diagrams.

From these diagrams can be seen the possible antisera which may arise by stimulation with any one of the eight genes. For example, $Rh_z$ will react with sera 1, 2 and 3 and will therefore be designated $Rh_{123}$; again, $Rh_1$ will react with sera 1, 3 and 5 and will therefore be called $Rh_{135}$. Thus the conclusion by Stratton[4] that $Rh_0$ can stimulate the production of sera 1, 2 and 3 would appear to be incorrect—$Rh_0$ can produce or react only with sera 3, 4 or 5.

A complete comparison of names of sera and genes with their corresponding reactions, including those of the two undiscovered sera, is given in the accompanying table. My numbering of sera and genes is compared with the original names and Prof. Fisher's recent notation described by Race[2].

REACTIONS OF EIGHT GENES TO SIX POSSIBLE ANTISERA (FOUR OF WHICH ONLY HAVE BEEN FOUND).

| | | | Antisera | | | | | |
|---|---|---|---|---|---|---|---|---|
| Wiener *et al.* Race and Taylor | | | Anti $Rh_1$ | Anti $Rh_2$ | Standard | *St* ? *Hr* | As yet undiscovered | |
| Fisher's notation | | | Γ | H | Δ | γ | η | δ |
| Suggested numbering | | | 1 | 2 | 3 | 4 | 5 | 6 |
| Red cell genes | | | | | | | | |
| $Rh'$ | *Cde* | $Rh_{156}$ | + | — | — | — | + | + |
| $Rhy$ | *CDe* | $Rh_{126}$ | + | + | — | — | — | + |
| $Rhz$ | *CDE* | $Rh_{123}$ | + | + | + | — | — | — |
| $Rh_1$ | *CdE* | $Rh_{135}$ | + | — | + | — | + | — |
| $Rh''$ | *cDe* | $Rh_{216}$ | — | + | — | + | — | + |
| $Rh_2$ | *cDE* | $Rh_{234}$ | — | + | + | + | — | — |
| $Rh_0$ | *cdE* | $Rh_{345}$ | — | — | + | + | + | — |
| $rh$ | *cde* | $Rh_{456}$ | — | — | — | + | + | + |

Selected from my series of families with fœtal hæmolytic disease, four illustrative cases show the mechanism of immunization of the mother, who can only become sensitized to an antigen of her husband which she herself does not possess.

There appears to be some variation in the response of individuals to similar antigenic stimulation. Thus an *Rh* negative mother ($Rh_{456}$) with a homozygous $Rh_1$ husband ($Rh_{135}$) usually produces a mixture of two antisera 1 and 3, giving together 87 per cent positive reactions (Wiener's anti-$Rh'$):

| | Father | Mother | Antiserum produced |
|---|---|---|---|
| Case 1 | $Rh_1Rh_1$ | *rhrh* | |
| Mrs. Ba. | 135 | 456 | Nos. 1 and 3 |

But in some identical matings the antiserum 1 giving 70 per cent reactions (Wiener's anti-$Rh_1$) may be produced:

| | Father | Mother | Antiserum produced |
|---|---|---|---|
| Case 2 | $Rh_1Rh_1$ | *rhrh* | |
| Mrs. Br. | 135 | 456 | No. 1 |

In these cases we must suppose that some antiserum 3 (Wiener's standard) is called forth, but only in such weak titre that it is not detectable under the conditions of the test, since we do find that the sera 1 and 3 may be in varying proportions so that it is sometimes possible to dilute out the antiserum 3 from the mixture retaining antiserum 1 in a strong workable titre. In the same way the figures 1 and 3 may be present in the genotype of the stimulating fœtal cells and yet an apparently pure antiserum 3 (Wiener's standard) may appear in the maternal serum:

| | Father | Mother | Antiserum produced |
|---|---|---|---|
| Case 3 | $Rh_1Rh_z$ | *rhrh* | |
| Mrs. R. | 135 123 | 456 | No. 3 |

Similarly, the two components of mixtures of antisera 2 and 3 giving 87·0 per cent positive reactions (Wiener's anti-$Rh''$) may vary, and we can only expect a pure antiserum 1 or antiserum 2 in cases where it is not possible for antiserum 3 to be stimulated, that is, where the figure 3 occurs in the genetic formulæ of both husband and wife:

| | Father | Mother | Antiserum produced |
|---|---|---|---|
| Case 4 | $Rh_2Rh_2$ | $Rh_1Rh_1$ | |
| Mrs. M. | 234 | 135 | No. 2 |

As yet, antisera 5 and 6 have not been demonstrated, although cases with a suitable genetic arrangement have been encountered. It may be just chance that no antibodies have been stimulated, or it may be that factors 5 and 6 are only weakly antigenic and do not readily provide the stimulus.

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[1] Wiener, A. S., *Proc. Soc. Exp. Biol. and Med.*, **54**, 316 (1943).
[2] Race, R. R., *Nature*, **153**, 772 (1944).
[3] Murray, J., *Lancet*, **2**, 594 (1944).
[4] Stratton, F., *Nature*, **153**, 773 (1944).

## Gramicidin S and its use in the Treatment of Infected Wounds

ANTISEPTICS of biological origin are now well known since the pioneer investigations of Fleming on penicillin and Dubos on tyrothricin. In our laboratory early in 1942 an attempt was made to isolate the strains of *Bacillus brevis* from Russian soils in order to prepare tyrothricin similar to that of Dubos. In the course of this work we isolated from soil a new strain of aerobic sporulating bacillus possessing some unique characteristics. It is well known that alcoholic extract of the acid precipitate of the culture of *B. brevis* contains an amorphous body, designated by Dubos and Hotchkiss (1941) as tyrothricin, which can be afterwards fractionated by special procedures into two individual crystalline substances, gramicidin and tyrocidine hydrochloride. In distinction from this, alcoholic extract of the acid precipitate from our strain consists almost entirely of the antibacterial substance, which is not amorphous but is directly crystallizable from the alcoholic solution. This crystalline substance can be further purified and obtained in the form of colourless needles with the melting point 267–268°. Hence it is different from gramicidin (m.p. 228–230°) and tyrocidine hydrochloride (m.p. about 240°). The bacteria producing this substance were designated as the strain of Gause-Brazhnikova, and the substance itself as gramicidin *S* (Soviet gramicidin).

*Chemical properties and antagonistic effect of gramicidin S.* Gramicidin *S* differs from tyrothricin, gramicidin of Dubos and tyrocidine hydrochloride by its easy solubility in chloroform. We had an opportunity of comparing directly gramicidin *S* with the original preparation of tyrothricin, obtained from Lederle, Inc., New York. Further, we were able to compare the properties of our strain of bacillus with that used by Lederle for the commercial production of tyrothricin. It was occasionally discovered that a batch of tyrothricin obtained from Lederle is heavily contaminated with spores of some bacillus. This bacillus was found to be identical with that described by Dubos, and with its aid we prepared a batch of tyrothricin identical with that offered by Lederle. It was observed by us that the spores of the Dubos strain of bacteria are much more resistant to the action of ethyl alcohol than the spores of the strain of Gause-Brazhnikova.

Although gramicidin *S* is similar to tyrothricin in many respects, a direct comparison shows that it is about four times more efficient in killing staphylococci than tyrothricin. Numerous tests made with various strains of pyogenic cocci on the nutritive media containing 10 per cent of human blood serum have shown that 25 gamma of gramicidin *S* per 1 c.c. of the medium is sufficient to kill staphylococci, whereas 100 gamma of tyrothricin is required for the same effect. These experiments were made with the commercial preparation of gramicidin *S*, which is now available in bulk. (Staphylococci are killed by pure crystalline gramicidin *S* at a concentration of 3 gamma, and *B. coli* at 50 gamma per 1 c.c. of the nutritive medium.) In the case of streptococci and pneumococci, 6 and 12 gamma of gramicidin *S* respectively are sufficient for the killing action, whereas about 3 gamma of tyrothricin has the same effect. It follows from these data that gramicidin *S* is more regular in its action upon various genera of pyogenic cocci, whereas tyrothricin has a weak action upon staphylococci and a strong effect upon streptococci and pneumococci. Because septic wounds containing staphylococci cause the most trouble, the advantage of gramicidin *S* for surgical practice is obvious.

The action of gramicidin *S* upon gas bacilli was studied by a number of methods. It was found that 10 gamma of this substance per 1 c.c. of the medium is sufficient to kill *Cl. Welchii* and *Cl. histolyticus.*

The toxicity of gramicidin *S* equals that of tyrothricine: the median toxic dose for intraperitoneal injections in rats is 15–20 mgm. per kgm. weight.

The use of gramicidin *S* in the prophylactic treatment of experimental infections was also studied. Experimental lacerated wounds of muscles in guinea pigs were infected with *Cl. Welchii*, treated either by gramicidin *S* solution (experiment) or by physiological saline (controls), and repaired. The mortality in experimental animals was 5 per cent, whereas in controls it attained 53 per cent. Similar experiments were made on rats, where the experimental wounds were infected by garden soil. The mortality of controls was 100 per cent, whereas in the rats treated by gramicidin *S* it was only 40 per cent.

*Clinical results.* Clinical application of gramicidin *S* was studied in 573 cases. The original 4 per cent alcoholic solution of gramicidin was diluted by water to make the concentration of gramicidin 400–800 gamma per c.c. of the liquid. These solutions were applied daily either locally, or introduced into cavities. The results of clinical observations can be summarized as follows.

The first group of cases includes septic gunshot wounds of the hip; the suppuration following heavy burns of the abdomen, breast, hip and hands; abscesses of the abdominal wall; heavy anaerobic phlegmones, etc. The application of gramicidin *S* has led to: (1) rapid disappearance of bacteria in the wound and successful epithelization; these processes were controlled by cytological and bacteriological observations; (2) successful preparation of the wound for subsequent surgical treatment (secondary joint or the transplantation of the skin); (3) in some cases the septic state disappeared through the elimination of the local suppuration process.

The second group of cases includes septic gunshot wounds of the larynx, chronical otitis, etc. The application of gramicidin *S* dramatically arrests the suppuration and rapidly improves the general state of the patient.

The third group of cases consists of empyæmas. Removing the pus by a syringe and introducing 50–100 c.c. of a water solution of gramicidin *S* into the pleural cavity two or three times is usually sufficient to eliminate the infectious process entirely.

The fourth group of cases includes osteomyelitis. The heavy suppurations of gunshot fractures are rapidly arrested by the local application of gramicidin *S*. In the cases of chronical osteomyelitis the application of gramicidin *S* immediately after the performance of sequestrectomy arrests the further spread of suppuration.

Details of experimental and clinical work with gramicidin *S* have been published in a monograph entitled "Soviet Gramicidin and Wound Healing", which is issued in Moscow in Russian. Copies of this monograph are available, and can be sent on application.

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## Symmetrical and Asymmetrical Post-reduction in Ascomycetes

The analysis of asci has shown that a pair of allelomorphic genes may segregate at the first meiotic division (pre-reduction) or at the second (post-reduction). Post-reduction may be symmetrical, with two like genes adjacent in the middle of the ascus, or asymmetrical. The analysis of 77 asci of *Neurospora sitophila* by Whitehouse[1], and 31 by Wilcox[2], Dodge[3] and Lindegren[4] has given the six possible patterns of the sex genes in the following numbers:

| | | | | | |
|---|---|---|---|---|---|
| Pre-reduction | + | + | − | − | 26 |
| | − | − | + | + | 24 |
| Symmetrical post-reduction | + | − | − | + | 10 |
| | − | + | + | − | 11 |
| Asymmetrical ,, ,, | + | − | + | − | 18 |
| | − | + | − | + | 19 |

The distal end of the ascus is represented to the left. There were thus 37 asymmetrical and 21 symmetrical post-reductions. The probability of so great a divergence from equality by chance is 0·049. If we add to these the figures obtained by Whitehouse for the segregation of 'weak', which is at least 41 units from 'sex' in the same chromosome, and of 'orange', which is in a different chromosome, based on 31 asci, and Dodge's data for albinism, which is also in a different chromosome based on 7 asci, we find 49 asymmetrical and 27 symmetrical reductions. The probability of obtaining such unequal numbers by chance is 0·016. On the other hand, Lindegren's data on 273 asci of *Neurospora crassa* show 14 asymmetrical and 25 symmetrical post-reductions. The difference is not significant; but it is unlikely that a larger count would show a majority of asymmetrical post-reductions. So asymmetrical post-reduction seems to be more frequent, at least for some genes, in *N. sitophila*, but not in *N. crassa*. Zickler's[5] results on *Bombardia lunata* show a slight but significant excess of asymmetrical post-reductions for the characters *lactea* and *rubiginosa*.

The greater frequency of asymmetrical post-reduction can be explained if the relative position of the chromatids generally remains unaltered during interphase.

Full details will be published elsewhere.

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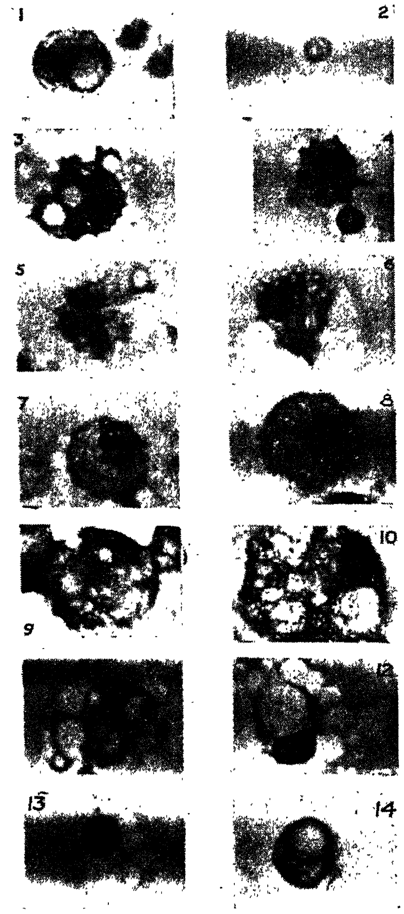
H. L. K. Whitehouse.
Departments of Biometry, University College, London, and of Botany, University of Cambridge.

[1] Whitehouse, *New Phytol.*, **41**, 23 (1942).
[2] Wilcox, *Mycologia*, **20**, 3 (1928).
[3] Dodge, *Mycologia*, **22**, 9 (1930).
[4] Lindegren, *Bull. Torrey Bot. Club*, **59**, 119 (1932).
[5] Zickler, *Planta*, **22**, 573 (1934).

## Cell Contents of Milk

Being interested in the study of the cell contents of milk, I have investigated the colostrum bodies present in fresh human and cow's milk. I devised two methods of studying the milk cells: in wet films, staining the nuclei with methylene blue; and by dry films, staining with May Grunwald Giemsa. The smears were made from fresh milk, at the commencement of lactation, and some smears were made from the cells deposited after centrifuging.

In the wet films, I found different groups of cells. (1) The first group were cells with polymorph nuclei, which appeared to be just a little larger than the normal polymorph, and their cytoplasm seemed to be formed by small fat droplets. (2) The second group were mononuclears containing a similar number of fat droplets to the previous group of cells, the droplets varying in size from those contained in the polymorphs to drops of more or less the size of red blood corpuscles. A few of the mononuclears in this group were two or three times the diameter of a polymorph. Their appearance was similar to the cells observed in the fluid obtained from some hæmorrhagic cysts in thyroid glands (described elsewhere). (3) The third group was composed of mononuclears containing a smaller number of fat droplets. Some of the smaller cells contained only one drop of fat and a small quantity of cytoplasm, giving the cell the aspect of a lymphocyte attached to a fat droplet.



*Wet Films.* Nos. 1 and 2. A mononuclear full of fat droplets; and a lymphocyte containing one drop of fat.
*Dry Films* (stained with May Grunwald Giemsa). Nos. 3, 4, 5, 6. Different polymorphs with different sizes of fat droplets.
Nos. 7, 8, 9, 10. Mononuclears in full process of secretion of fat droplets.
Nos. 11, 12, 13. Cellular remnants of fat secretion. In Nos. 12 and 13 the remnants appear as lymphocytes.
No. 14. Protoplasmatic remnants framing some fat droplets.

In the dry films, the cells could also be divided into groups and confirmed what we had previously seen in the wet films. By careful observation, however, it could be seen that the cells were not in three distinctly different groups, but were linked together by intermediate cells. The groups observed in the dry films were as follow: (1) The first group was formed by polymorphs which appeared to be of the neutrophil variety, part of their cytoplasm consisting

mainly of empty vacuoles. The material contained in these vacuoles had probably been dissolved in the alcohol used as a solvent for the stain. These polymorph cells had different aspects, and the vacuoles contained in them were of different sizes. In some of the cells the nucleus was compressed by the large size of the fat droplets, and in the cells generally the change in the nuclei towards a mononuclear could be followed clearly. (2) The second group consisted of a range of mononuclear cells of different sizes, each having a large quantity of cytoplasm containing vacuoles. Some of the cells were of very large size, and some of the vacuoles contained in these large cells had a diameter about the size of a red blood corpuscle. (3) The third group consisted of cells still containing vacuoles; but the cells were closer to the classical description of a peripheral blood monocyte. It could be observed that some of these cells in evolution were linked with the lymphocyte, and some of the lymphocytes present still contained vacuoles in their cytoplasm.

Another fact which could be seen clearly was that some cells liberate portions of their cytoplasm, each such portion taking on the form of a round drop. Some of these free cytoplasmic portions still framed empty vacuoles.

After systematic observation of different specimens of human and cow milk in which I had followed the monoglandular fat secretions, I was able to draw similar conclusions to those arrived at after my study of blood formation, previously published elsewhere.

My grateful thanks are due to my technician, Mr. Jeffrey B. Dean, who has made the photomicrographs.

*Conclusions.* (1) It appears that a number of fat droplets, if not all, are not produced by the mammary gland itself but are carried there by cells. (2) The cells responsible for the carriage of the fat are a kind of polymorph neutrophil. (3) The cell that secretes the fat droplets is the same polymorph neutrophil that carries the fat to the gland, but it changes its nuclear morphology and its size before it undertakes the process of secretion. (4) After secreting and expelling its cytoplasmic fat droplets, the cell has the appearance of a lymphocyte.

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## Determination of Molecular Weights by the Cryoscopic Method

THE difficulty of obtaining consistent results in the determination of molecular weights by the cryoscopic method has led Brancker, Leach and Daniels[1] to suggest a modified form of the classical cryoscopic equation. The difficulty arises from the fact that as the concentration of the unknown solute is changed, the molecular weight, as calculated by the classical equation, does not remain constant. In order to overcome this difficulty, these workers used the equation

$$\Delta T = K_f m^b.$$

In this laboratory we have confirmed that unless special methods of calculation are used, inconsistent results are invariably obtained, the inconsistency becoming more marked as the molecular weight of the unknown increases. It has been found, however, that results can be duplicated within narrow limits by the use of the above modified equation. Table 1 shows the results obtained on a series of oils. Duplicate figures on each material were obtained with different samples of solvent (benzene). The cryoscopic constant was determined on each sample using naphthalene as solute, and five depressions of freezing point were determined on each material, including standardizations with naphthalene.

TABLE 1.

| Oil | $b$ | $\log K_f$ | $M$ | ($M$ Theoretical) |
|---|---|---|---|---|
| Dibutyl phthalate | 1·0173<br>0·9990 | 0·6885<br>0·6953 | 256·1<br>259·4 | 278 |
| Tricresyl phosphate | 0·9927<br>0·9751 | 0·6890<br>0·6921 | 349·1<br>335·1 | 368 |
| "Octoil S" | 1·0968<br>1·0789 | 0·6885<br>0·6890 | 340·2<br>341·5 | 426 |
| "Octoil" | 1·0314<br>1·0186 | 0·6885<br>0·6890 | 352·5<br>352·0 | 390 |
| "Litton" oil | 0·9597<br>0·9723<br>0·9350 | 0·6953<br>0·6953<br>0·6885 | 486·1<br>491·0<br>487·6 | — |
| Pump lubricating oil | 1·0162<br>0·9925 | 0·6953<br>0·6890 | 301·1<br>311·8 | — |
| "Arochlor 1254" | 1·0129<br>1·0228 | 0·6921<br>0·6953 | 327·9<br>315·8 | — |
| "Apiezon A" oil | 0·9468<br>0·9584 | 0·6890<br>0·6885 | 445·1<br>448·7 | — |
| "Apiezon B" oil | 0·9613<br>0·9495 | 0·6953<br>0·6885 | 523·7<br>515·9 | — |

It will be seen that the results are very consistent. It is also interesting to note that values of $b$ in excess of unity may be obtained. The cause of this has not been determined. Dibutyl phthalate, tricresyl phosphate, 'Octoil' (di-octyl phthalate) and 'Octoil S' (di-octyl sebacate) were obtained commercially, and as they were to be compared with other materials, no attempt was made to purify them. A comparison of their theoretical and determined molecular weights has been made in Table 1. While the discrepancy between these figures is fairly large, it must be remembered that the materials were not pure, and in addition the determined figures on each sample are in very good agreement. The modified equation is admittedly empirical and must be judged as such until other methods of checking molecular weight determinations have been carried out.

Brancker, Leach and Daniels have compared the results obtained with the classical equation with those obtained with the modified equation. In their table of results, they have calculated $K_f$ according to the latter equation and substituted in the classical. Another method of calculation would be to calculate $K_f$ and the unknown molecular weight at the same concentration of solute in both cases, using the classical equation.

Neither of these methods is permissible. The latter is only applicable when the molecular weight of the unknown is of the same order as the standardizing solute (namely, 128 in the case of naphthalene).

It must be borne in mind that the use of osmotic or cryoscopic methods for determination of molecular weight lead to a 'number average', and hence comparable values are only obtained when equal molalities of solution are used in both $K_f$ and unknown molecular weight determinations. For example, the concentration of an unknown compound

of molecular weight 400–500 should be four times as high when its depression is found as the naphthalene concentration when $K_f$ is determined.

This method of calculation has been used for 'Litton' oil (Table 2), and it will be seen that the average result obtained is comparable with that obtained by the modified equation. The figures in the second column of this table are those obtained from the classical equation using the cryoscopic constant calculated from the modified equation.

TABLE 2. COMPARISON OF RESULTS OBTAINED USING MODIFIED AND CLASSICAL EQUATIONS.

("Litton" oil).

| Modified equation | | Classical equation | | "Number average" (see text) | |
|---|---|---|---|---|---|
| 495·1 | 491·0 | 451·2 | 460·0 | 476·8 | 481·4 |
| 489·8 | | 455·9 | | 478·7 | |
| 481·7 | | 452·9 | | 474·2 | |
| 488·9 | | 463·3 | | 483·1 | |
| 499·4 | | 476·6 | | 494·2 | |

From the figures obtained in this Laboratory, there seems to be little doubt as to the greater consistency of results using the modified equation over those obtained by the classical method of calculation. For purposes of laboratory control of products, this is essential.

A comparison of results obtained by osmotic and cryoscopic methods of determination of molecular weight would be interesting and may prove of considerable importance in the determination of molecular weights of high polymers.

I wish to thank Dr. A. P. M. Fleming, director of research and education, Metropolitan-Vickers Electrical Co., Ltd., for permission to publish these notes.

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[1] Brancker, Leach and Daniels, *Nature*, **153**, 407 (1944).

## Formation of Sulphamic Acid during the Thermal Decomposition of Ammonium Sulphate

THE thermal decomposition of ammonium sulphate appears to have received little attention since the recorded observations of Jänecke in 1921[1]. Consequently it has become accepted that decomposition results first in the formation of ammonium acid sulphate with the liberation of ammonia, and then, after partial elimination of water from the acid sulphate, the pyrosulphate is formed.

Recent observations in this laboratory have revealed that sulphamic acid is also formed during the thermal decomposition of either the normal or the acid sulphate. Analyses of residues obtained from heating A.R. ammonium sulphate at 400° C. indicated that they consisted predominantly (90 per cent) of ammonium pyrosulphate, together with small amounts of the acid salt and unchanged ammonium sulphate. However, it was found that when the residues were treated with water and redried at 150° C., the resulting increase in weight was greater than could be accounted for by hydrolysis of pyrosulphate to the acid salt. This indicated that one of the components of the mixture contained even less water than ammonium pyrosulphate, and the presence of sulphamic acid was thus suspected.

Quantitative measurements of sulphamic acid by the gas volumetric method of Meuwsen and Merkel[2] have shown that about 5 per cent of sulphamic acid is present after 1 hour at 400° C. The results given in the accompanying table are representative of the composition of the residues obtained.

The evolution of sulphur dioxide and nitrogen from strongly heated ammonium sulphate, which has previously been ascribed to the decomposition of the acid salt[3], is probably due to the thermal decomposition of sulphamic acid which is first formed.

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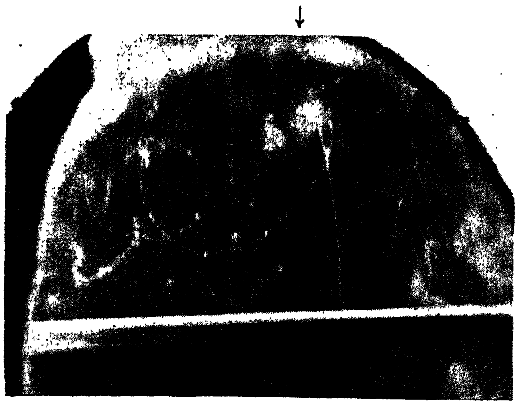
[1] Jänecke, *Z. angew. Chem.*, **34**, Aufsatzteil, 542 (1921).
[2] Meuwsen and Merkel, *Z. anorg. allgem. Chem.*, **244**, 89 (1940).
[3] Smith, *J. Soc. Chem. Ind.*, **14**. 629 (1895).

## Application of a Randomly Operated Large Wilson Cloud Chamber for the Determination of the Mass of the Meson

DURING recent years, increasing interest has been shown in the accurate determination of the mass of mesons, which have been supposed to constitute the penetrating component of cosmic rays. The most direct evidence that such particles have an intermediate mass lying between that of an electron and a proton comes from cloud chamber observations. The momenta of the particles and ionization they produce are directly available from the measurements on the cloud chamber tracks, and are found to be compatible with theory only when the particles are assumed to possess a mass roughly equal to 200 times the mass of an electron. An accurate determination of the mass is possible only when the particle can be photographed near the end of its path through space, and this occurs rarely. Slow mesons seem to be particularly rare in counter-controlled photographs with a thick lead plate inserted inside the chamber, apparently because (1) they have extremely short range in heavy material, (2) they have a large probability of decay, nuclear absorption and transformation into neutrettos[1]. Hence they fail to trip the lower counter of the coincidence system.

A large randomly operated cloud chamber has been found[2,3] to be very satisfactory for such investigations, and with the view of determining the mass of mesons, their decay products and the absorption processes, such a cloud chamber has been built. Progress has been very slow, and due to shortage of films only three hundred photographs could be taken altogether, of which the accompanying photo-

| $(NH_4)_2SO_4$ (gm.) | Temperature °C. | Time of heating (hr.) | Residue (gm.) | Composition of residue (per cent). | | | |
|---|---|---|---|---|---|---|---|
| | | | | $(NH_4)_2SO_4$ | $NH_4HSO_4$ | $(NH_4)_2S_2O_7$ | $NH_2SO_3H$ |
| 5·0000 | 400 | 1·0 | 3·5499 | 10·3 | 13·5 | 70·2 | 5·7 |
| 5·0000 | 400 | 1·25 | 3·4817 | 9·9 | 11·2 | 73·2 | 5·7 |



graph is one. The interesting feature of the track marked by an arrow is that it ends just a centimetre above the lead plate. The absence of any decay product in the neighbourhood indicates the absorption of a meson by a nucleus present in the gaseous volume of the chamber. The charge carried by the particle is negative. It is interesting to note that decay products are obtained only in the case of positive mesons, while negative mesons show absorption. Rassetti[4] has pointed out that this may be because slow positive mesons are repelled by the positively charged nuclei. The other suggestion given by Hamilton, Heitler *et al.*[1] is that when a meson has reached an energy which is lower than four times its rest energy, the chance that it will be transformed into a neutretto on interacting with a nuclear particle is so large that only 21 per cent of them can reach the end of their range as charged mesons.

The ionization density along the photographed track is too heavy to allow direct counting under the microscope. Another method that has been experimentally verified and used by Williams and is particularly suitable for large ionization density is the counting and measurement of the long free paths of the particle observed along the track which appear as gaps. The average number of such free paths, greater than $g$ cm., is given by the well-known formula of random collisions, $n = Il \times e^{-Ig}$, where $I$ is the ionization density and therefore the inverse of the mean free path, and $l$ is the length of the track. In this case only one free path was measured on 5·2 cm. of track and was found to be 0·056 cm., being corrected for the width of the track. Hence $5{\cdot}2\,I \times e^{-0{\cdot}056\,I} = 1$ and $I = 113$ ions/cm., which after correction for temperature and pressure gives $I = 106$ ions per cm. at N.T.P.

The track was photographed in a magnetic field of 1,060 oersteds. The curvature was measured by finding the value of the dips at different points along the track. The radius of curvature was found to be 76 cm. Hence $H\rho = 8{\cdot}056 \times 10^4$ gm. cm.

Now $pc = 300\,H\rho$ ev. On substitution of the values, we obtain $p = 48\ mc$, where $m$ is the mass of the electron. From the work of Williams and Terroux[5] the primary ionization has been found to vary as $\beta^{-1{\cdot}4}$, where $\beta = v/c$. They give the primary ionization density for an electron of velocity $0{\cdot}96c$ as 22 ions/cm. in air. Thus for the incident particle

$$\beta = 0{\cdot}96(22/106)^{1/1{\cdot}4} = 0{\cdot}31.$$

$$\text{But } p = M\beta c/\sqrt{1-\beta^2} = 48\ mc,$$

where $m$ is the mass of the incident particle.

$$\text{Hence } M = 48\,m.\sqrt{1-\beta^2}/\beta = 147\text{ cm.},$$

on substituting the value of $\beta$. The mass of the incident particle is thus in fair agreement with the mass of the meson, obtained by different workers. Further work is in progress.

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[1] Hamilton, Heitler and Peng, *Phys. Rev.*, **64**, 78 (1943).
[2] Williams, *Proc. Roy. Soc.*, A, **172**, 194 (1939).
[3] Maier-Leibnitz, *Z. Phys.*, **112**, 569 (1939).
[4] Rassetti, *Phys. Rev.*, **60**, 198 (1941).
[5] Williams and Terroux *Proc. Roy. Soc.*, A, **126**, 289 (1930).

## Vapour Pressure of Solids at Low Temperatures (and the Origin of the Planets)

IN a letter on the origin of the solar system, in *Nature* of January 29, Dr. Harold Jeffreys speaks of the importance of estimating the vapour densities of ordinary solids at the hypothetical temperatures of the condensation of the planets; the problem, as he puts it, being largely whether a gas at some not very small fraction of $10^{-15}$ density can condense at 400° A.; he adds that he has not been able to find data on the subject.

In the past, during studies of theist cosmology, I made an estimate of the vapour density of iron, which is no doubt the least easily condensed of the substances significant in the planetary matter, finding it to be about $10^{-44}$ at 273° A., and the temperature for saturation at the sort of density of iron supposed to exist in galactic space ($10^{-29}$) to be about 400° A. Much rougher corresponding values for calcium oxide, based on a boiling point estimated as best one could, were $10^{-113}$, and 1400° A.

In the foregoing the latent heat of vaporization was assumed to be constant, but a more accurate estimate (yet not differing widely from the other) is obtained as follows:

Iron will probably have closely the normal 'Trouton quotient', 21, as mercury has: hence its molecular latent heat at its boiling point (2723° A.) will be 2,723 × 21 = 57,183 cal. Now while the molecular (specific) heat of the monatomic gaseous iron will not change much with temperature, that of the solid is known to increase between 273° A. and 1273° A., as if to become trebled* at 2723° A.: so that, in the Clausius-Clapeyron equation $d\log_e p/dT = L/RT^2$, we add to $L$ (= 57,183) the difference between the heat capacities of the gas and the solid (or liquid) between the two temperatures considered (which is $14{,}250 - \frac{0{\cdot}00465\,(T-273)^2}{2}$). Then

$$\log_e \frac{p \text{ at } 2{,}723^\circ}{p \text{ at } 273^\circ} = \frac{1}{R}\left[\frac{-57{,}183}{T} + \frac{14{,}250}{T} - 0{\cdot}00465\left(T - 546\log T - \frac{78{,}000}{T}\right)\right]_{T=273^\circ}^{T=2{,}723^\circ}.$$

$$= 119 - 5{\cdot}7 + 2{\cdot}9 - 0{\cdot}6 = 115{\cdot}6;$$

whence the vapour pressure at 273° A. is $10^{-50{\cdot}26}$ atmospheres, corresponding to a density of $1{\cdot}3 \times 10^{-53}$, while the temperature of condensation at a density

* *Note added in proof.* 'More than doubled' is perhaps nearer the case; however, a factor of only one and a half would be sufficient.

$10^{-x}$ is roughly $273 \times (53/x)^2$, that is, 910° A. at a density $10^{-16}$ (500° A. at $10^{-29}$).

It is evident, of course, that 'earthy' substances would condense very much more easily still.

As the error in the 'Trouton quotient' is most unlikely to be greater than 10 per cent (which makes an 8 per cent error in the index of the result), and an error of as much as 50 per cent in the specific heat makes only a 10 per cent error in that index, the estimates have presumptively considerably more than the accuracy essential to the purpose.

The subject will be discussed more fully elsewhere.

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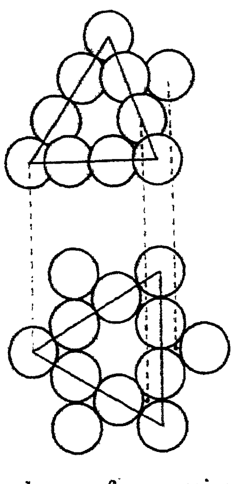
## Open Packing of Spheres

IN their study of the open packing of equal spheres, Heesch and Laves[1] do not consider cases in which the number of spheres with which each sphere makes contact is greater than four; and at first sight it might not perhaps appear worth while to go further, for in the cubic arrangement of spheres which Barlow[2] styled his "second kind of symmetry", each sphere makes contact with six, and it has a density of 0·524.

Another and much more open arrangement with six-point contact is, however, possible; part of this structure is shown in the accompanying figure. For the sake of clearness only the spheres of the initial layer are indicated in the plan. The centres of these spheres lie at the vertices of a plane tessellation of equilateral triangles and hexagons. The spheres of the second layer lie over the centre of alternate triangles of the first layer. The third and all other odd-numbered sheets are congruent with the first but are translated. The fourth and all other even-numbered layers are congruent with the second but are also translated. These translations are of such a kind as cause the spheres of successive sheets to lie on the edges of regular tetrahedra, four spheres on each edge, as shown in the figure. The seventh layer lies over the first.



This structure has a density of 0·370, which must be reckoned remarkably low having regard to the fact that in it each sphere makes contact with as many as six others: it bears comparison with the well-known structure of diamond in which, although each sphere makes contact with only four, the density is 0·338.

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[1] Heesch, H., and Laves, F., *Z. Krist.*, **85**, 443 (1933).
[2] Barlow, W., *Nature*, **29**, 186 (1883).

## The Perithecial Stage of *Didymella Lycopersici*

THE perithecial stage of the fungus that causes stem rot of tomato was found and described in 1921 by Klebahn[1], who named it *Didymella Lycopersici*. It was apparently not observed again until I found it in October 1943 on a single plant growing at Long Ashton, and since then mature perithecia have been found on three occasions*. Confirmation of the identity of the fungus has been obtained in pathogenicity experiments with single ascospore cultures.

The plant on which perithecia were found in October 1943 was one of a number that had been grown experimentally, out of doors, in pots of soil collected from a field where stem rot had severely attacked two successive crops of outdoor tomatoes. The characteristic basal stem lesion appeared early in August, but it was not until the middle of October that the plant was carefully examined. Pycnidia were then present on the upper part of the lesion; but below them, and down to soil-level, numerous perithecia were present among the disintegrating remains of the cortical tissues. At the end of December 1943, perithecia were found at or near ground-level on a number of plants at Evesham. These plants formed part of a group that had succumbed to artificial inoculation with pycnidial cultures during the summer. In the middle of July last, the perfect stage was again seen on pieces of diseased stems of affected greenhouse plants, collected at the end of May and kept moist on the surface of soil in a pot. The material had been examined from time to time but it was not until the middle of July, by which time the bulk of the cortical tissues had disappeared and only a few fructifications remained, that perithecia were found. Lastly, some diseased outdoor plants, grown from infected seed, were examined at the end of July, and one of them bore perithecia. The perithecia occurred well below ground-level, in a place that must have been approximately at soil level when the plant was in the propagating box. The cortex in this region had entirely disappeared, and scattered perithecia were attached to the woody tissues.

Klebahn[1] stated that perithecia appear after overwintering. His conclusion was based on observations on pieces of diseased stem, exposed in the open during winter, on which perithecia were observed the following April. My observations show that perithecial development is not dependent on an overwintering period, but may occur at any time of year. The constant presence of perithecia near to the soil suggests that moisture supply and, possibly, soil nutrients may be factors governing their formation.

This appears to be the first record of the occurrence of perithecia of *D. Lycopersici* under natural conditions on the host. The observations have largely been confined to outdoor plants, but it is not unlikely that the perithecial stage also occurs on glasshouse plants attacked by stem rot. Notwithstanding the proved viability of the imperfect, pycnidial stage it is possible that perithecia may play a more important part in the survival of the fungus than has hitherto been recognized.

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* These observations were made while the writer was a member of the scientific staff of the Agricultural Research Council.

[1] Klebahn, H., *Z. Pflanzenkrankheiten*, **30**, 1 (1921).

## 'Pasmo' Disease on Wild Flax, *Linum angustifolium*

THE summer of 1944 was outstanding in Ireland with regard to the severity of flax diseases. Both *Phoma* and rust (*Melampsora Lini*) were widespread and virulent, the first mentioned being particularly bad on crops raised from home-saved seed.

During an examination of some species of wild flax as to their probable role in the perpetuation of common flax diseases, a pycnidial fungus was found on the leaves and stems of *Linum angustifolium*; and, on incubating affected material, horn-like tendrils of four-celled spores were extruded from the pycnidia. Morphologically, the causal organism agreed with published descriptions of *Sphœrella linorum*, the cause of 'Pasmo' disease of flax. Using spore suspensions, cross-inoculations on seedlings of *Linum usitatissimum* showed that the disease went over readily to the ordinary flax. Lesions and typical pycnidia containing three septate spores soon developed, and the symptoms on the host here corresponded closely with those described for 'Pasmo' disease. The plants of *L. angustifolium* on which the disease was originally found came from a farm in one of the southern counties. Flax has been cultivated both on this farm and in its vicinity for a number of years, and seed of foreign origin frequently used.

Colhoun and Muskett[1] issued a warning note in *Nature* as to the danger of introducing 'Pasmo' disease into these islands. Although not yet recorded on ordinary flax in Ireland, it is probable that a close inspection of the crop will show this disease to be present. In any event, the indications are that not only has the disease been introduced in the past but also that it has already become established on a native weed. In this connexion it is interesting to note that in New Zealand the 'Pasmo' disease soon after its introduction established itself on *Linum marginale* (an introduced weed), and the disease was afterwards more abundant on this plant than on neighbouring crops of cultivated flax[2].

Incidentally, it may be mentioned that the seedling blight fungus *Colletotrichum linicola* was also found on plants of *L. angustifolium*, and here again cross-inoculations showed the fungus to go over readily to cultivated flax.

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[1] Colhoun, J., and Muskett, A. E., *Nature*, **151**, 223 (1943).
[2] Newhook, F. J., *New Zealand J. Sci. Tech.*, A, **24**, 102 (1942). (Abst. *Rev. Appl. Mycol.*, **23**, 17 (1944).)

## Wilt Disease of Flax in Great Britain

FOR the last three seasons a serious disease has occurred in some experimental plots at Aberystwyth in which oil varieties of flax, *Linum usitatissimum* L., have been grown. *Fusarium Lini* Bolley (*F. oxysporum* Schlecht form *lini* (Bolley) Snyder and Hansen) has been repeatedly isolated from the stems, roots and seeds of the diseased flax plants. This species, first described by Bolley[1] in 1901 as the cause of wilt disease of flax in America and recorded as occurring in Ireland by Pethybridge and Lafferty[2] in 1920, has not previously been reported in Great Britain.

*F. culmorum* (W. G. Sm.) Sacc. has also been found closely associated with *F. Lini* on flax seed. Rost[3] claims that *F. culmorum* causes a foot and root rot of flax and up to 100 per cent loss in germination under adverse weather conditions. In view of this statement further work is in progress on the pathogenicity of this species alone and in combination with *F. Lini*.

The two species of *Fusarium* mentioned above were identified by Dr. W. L. Gordon of the Dominion Rust Research Laboratory, Canada, to whom they were sent through the Imperial Mycological Institute, Kew, and I gratefully acknowledge this assistance.

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[1] Bolley, H. L., Proc. 22nd Ann. Meet. Soc. Promotion Agric. Sci., 1 (1901).
[2] Pethybridge, G. H., and Lafferty, H. A., *Irish J. Agric.*, **20**, 325 (1920).
[3] Rost, H., *Angew. Bot.*, **20**, (6), 412 (1938).

## Stridulations in the South African Egg-eating Snake, *Daspeltis scaber*, Linn.

MANY strange vocal sounds have been attributed to snakes, but none substantiated. At this Snake Park I have listened carefully both during the day and night, at all seasons and particularly at mating periods, and have never heard any sound other than a hiss. Just recently, however, I observed stridulation in an egg-eater, and have since confirmed this in other specimens.

Normally, the egg-eater is a quite docile snake and can be handled with impunity. An occasional specimen, however, can be easily irritated, when it will throw its body into a series of horseshoe-shaped coils with the head in the centre. By doing this, the scales of any two opposing portions of the body point in opposite directions. The snake writhes its body in such a manner that new coils are continually added on the inside of the horseshoe; at the same time the body is slightly inflated to act as a resonator. In the process of writhing, the tips of the scales rub against each other and produce a rasping sound which is amplified by the inflation of the body. This sound is very similar to a hiss and can easily be mistaken for it. Each spasm of writhing is kept up for only 15–20 sec., and during this time the snake opens its mouth and strikes.

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## Meaning and Scope of Social Anthropology

PROF. A. R. RADCLIFFE-BROWN's article in *Nature* of August 26 has just come to my notice, and I hasten, regrettably late I fear, to write to point out that his able exposition of meaning and scope of anthropology does scant justice to Prof. F. C. Bartlett,

whose Huxley Lecture, as I understand it, cannot bear the interpretation placed on it.

Prof. Radcliffe-Brown says that Prof. Bartlett "would give no place in anthropology to archæology, to linguistics, . . . to ethnology . . . or to social anthropology". He must, I think, have misunderstood what Prof. Bartlett said. What Prof. Bartlett did was to advocate a more intensive empirical and, so far as possible, controlled study of the behaviour of contemporary social groups. He stated very clearly in the fourth paragraph of his lecture, as printed in *Nature* (Dec. 18, 1943), that there were many other concerns of anthropology which he hoped would "continue to be studied vigorously". He excluded archæology from anthropology only to the extent of treating it as an aspect of that study which had not "kept close to empirical fact", and he stated specifically that it could be adopted as a line of approach to the four main branches of anthropology which did rely on such "empirical fact". Linguistics I do not think Prof. Bartlett mentioned at all by name, but one must in reason assume them to be one of those unspecified branches of anthropology which he wished to have vigorously pursued; as for ethnology and social anthropology, as defined by Prof. Radcliffe-Brown, I can infer nothing from Prof. Bartlett's lecture except that he regards their study with the greatest approval and appreciation, and is anxious only to "forge a link closer than ever before" between the work of the anthropologist and the psychologist in their pursuit.

Prof. Bartlett is a psychologist and his whole lecture was, naturally, given specifically from a psychologist's point of view, though I doubt if he would endorse the views expressed by Prof. Radcliffe-Brown as to the nature of psychology and 'psychologies'.

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(President.)

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## Origin of Semitic Languages

THE mouth gesture theory of the origin of human speech as it is put forward by Sir Richard Paget and by Prof. Alexander Jóhannesson[1] is certainly a valuable contribution to research on the origin of human speech, although it is not favourably regarded by comparative linguists to-day. It seems that they want to leave the matter to the anthropologists, who are beginning to show considerable interest in it.

A predecessor of Sir Richard Paget and Prof. Jóhannesson was the philosopher Schopenhauer. In his "Psychological Observations" he writes[2]:

". . . Natural gesticulation such as commonly accompanies any lively talk, is a language of its own, more widespread even than the language of words—as far, I mean, as it is independent of words and alike in all nations."

". . . As I have said, the most interesting and amusing part of the matter is the complete identity and solidarity of the gestures used to denote the same set of circumstances even though by people of different temperament, so that the gestures become exactly like words of a language alike for every one. . . . And yet there can be no doubt but that these standing gestures which everyone uses are the result of no convention or collusion. They are original and innate—a true language of nature. . . ."

Schopenhauer, however, makes a proviso:

". . . Strictly speaking, what I get from gesticulation alone is an abstract notion of the essential drift of what is being said. . . . It is the quintessence, the true substance of the conversation and it remains identical no matter what may have given rise to the conversation or what it may be about."

I have tried, in a work as yet unpublished, to reconstruct in another way the origin of human speech and to demonstrate the identity of the Indogermanic and Semitic languages. I do it with the help of the facts of physiology, of 'animal languages', the 'language' of the suckling and the psychology of primitive men. It was possible to deduce most of the words of the Indogermanic and Semitic languages from this reconstructed first language.

A combination of the two theories may perhaps help to further progress and to shed more light on the origin of the most human faculty of human beings.

ARNOLD HAHN.

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Oxford.

[1] *Nature*, 154, 466 (1944).
[2] Translation by T. Bailey Saunders in "Studies in Pessimism".

## First Use of Current-Bedding to Determine Orientation of Strata

IN a recent letter[1], Dr. Archie Lamont directed attention to John Kelly's account, published in 1864, of the use of current-bedding to decide which way up strata were lying. Kelly gave the credit for the discovery of the method to Patrick Ganly. Ganly had given a description of it to the Geological Society of Dublin in 1856[2], but he had been using it much earlier.

Recently, three volumes of letters on geological subjects written by Patrick Ganly to John Kelly and Richard Griffith between 1838 and 1848 have come to light among the records in the Valuation Office in Dublin. These are at present deposited in the library of the Royal Irish Academy, through the courtesy of the Commissioner of Valuation. In one of the letters, dated June 18, 1838, from Dingle, and in another, dated July 16, 1838, from Glengarriff, he uses the method to work out the local structures. Both letters are accompanied by sketches of current-bedding. In the first case he deduces an inversion in the Dingle Beds at Fahan, and in the second shows that in passing from the Red Slate Series to the Black Slate Series (from the Old Red Sandstone to the Carboniferous Slate) south-east of Glengarriff, "the natural order of the succession of the strata accords with their present order of superposition".

Ganly was one of the boundary surveyors engaged on the Griffith Valuation of Ireland. He was employed by Griffith on geological work, and his surveys seem to have been the basis of much of the revision of the later editions of Griffith's geological map of Ireland, first published in 1838.

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[1] *Nature*, 145, 1016 (1940).
[2] "Observations on the Structure of Strata", *J. Geol. Soc. Dublin*, 7, 164 (1856).

# PROGRESS OF GEOLOGY IN THE U.S.S.R.

SOVIET writers have good cause for satisfaction in the achievements of their country in the field of geology since the Revolution of 1917. This justifiable self-satisfaction has a less justifiable corollary in the constant emphasis on the backwardness of pre-Revolutionary Russia. The pace of scientific progress has increased everywhere in the last few decades, both from its own momentum and because of the vast increase in the number of workers in the field; but this should not detract from our appreciation of the worth of earlier patrons and scholars working in less favourable circumstances.

Russia could boast a mineralogical museum, of a sort, as early as 1716. It was founded by Peter the Great, who was also responsible for the start of a systematic survey of the Russian Empire. By the middle of the century, the great Russian scientific worker M. V. Lomonosov (1711–65) was actively engaged in geological work, and later in the same century, in 1773—a date at which no similar institution existed in Great Britain—the Mining Institute of St. Petersburg was founded. It is true that in the eighteenth century and even later the bulk of the geological work in Russia was carried out by foreigners, among whom the name of Sir Robert Murchison is outstanding. Gradually, however, the Russian geologists asserted themselves and a number of them achieved recognition in the international sphere. Such were A. A. Inostranzev, I. V. Mushketov, M. V. Pavlov, A. P. Karpinsky, E. S. Fedorov, F. Y. Loewinson-Lessing and many others. It is claimed, however, that the progress made during the past twenty-five years exceeds by far all previous achievements. This is probably true, if one considers the scale of the geological research and the number of workers engaged. It is estimated that in 1914 no more than three hundred professional geologists existed in Russia, and that vast territories such as Siberia, Central Asia and the Caucasus were served by only a handful of men. Although it is impossible to estimate the present numbers engaged in geological work in the U.S.S.R., it must be at least ten times as large. At the last International Geological Congress held in Moscow in 1937, the Russian membership exceeded 1,500 members, and this figure did not include many junior workers.

This Congress and the recently published book[1], which is the main subject of this review, must be taken together as an attempt to make widely known the results of a quarter of a century of endeavour in the field of geology (and the kindred sciences of mineralogy and petrology) and the stages by which those results were achieved. The Congress aimed mainly at the enlightenment of non-Russian men of science; on those who were fortunate enough to be present in Moscow and on the elaborate field excursions it will leave an indelible impression. For those who have no such personal recollections, the guide-books and published abstracts of papers provide no adequate substitute. On the other hand, the collection of twenty-five articles on the various branches of geology which comprise the "Progress of Geological and Geographical Sciences in the U.S.S.R. during Twenty-five Years" are very full and well documented, but they are in Russian.

Each article is the work of a prominent authority on its subject, and the whole collection is edited by the veteran Russian geologist V. A. Obruchev. All branches of geology are represented (including one article on geography) with the exception of palæophytology and the regional geology of European Russia, which are missing because the War has absorbed the energies and the time of the men who were to have been responsible for them. It is impossible in this review to give an adequate exposition of the book, but it may be useful to indicate some of its most important points.

First come the articles dealing with the progress made in mineralogy and petrology. These are very informative and they provide a good account of the work of different research schools, such as that on crystal optics originated by E. S. Fedorov, physico-chemical analysis by N. S. Kurnakov, mineral synthesis by D. P. Grigoriev and geochemistry by V. I. Vernadsky and A. E. Fersman. In petrology, naturally, the name of F. Y. Loewinson-Lessing comes first, but much has been achieved by many other petrologists—D. S. Belyankin, B. M. Kupletsky, V. N. Lodochnikov, A. N. Zavarizky and others. The Petrographical Institute founded in 1931 is in a way unique in the whole world, and in the short period of its existence has published, besides the periodical *Travaux de l'Institut Petrographique*, a great number of monographs on the regional petrography of the U.S.S.R., on various rocks and rock-forming minerals. Technical petrology is also extremely well developed in the U.S.S.R., and a number of workers are engaged on the study of slags, cements, fire-resisting materials, glass and cast basalt.

The articles dealing with the progress of palæontology are rather short. On the other hand, those on stratigraphy are the longest and the most valuable of the book. The industrial prospecting for coal, oil and bedded ores is no doubt partly responsible for the progress made in these branches of geology, and it is significant that the greatest amount of work has been done in the study of Carboniferous and Tertiary rocks, the main sources of coal and oil. This does not preclude the achievement made in the study of other systems, and geological mapping and surveying is constantly on the increase all over the territory of the U.S.S.R., but more particularly in the Urals, Siberia, Central Asia and the Caucasus. During this new survey, many startling discoveries have been made, discoveries which have often led to a complete revision of previously accepted knowledge. Stratigraphical work nearly always involves tectonics, and the technique of tectonic investigation recently developed in western Europe and the United States has been applied with the greatest effect by Russian workers. The major tectonic problems, sometimes called geotectonics, have received a good deal of attention, and as so often happens have become involved in a tangle of conflicting hypotheses of a highly speculative nature. For example, a well-known Russian geologist, M. M. Tetiaev, raised a storm recently by a hypothesis which postulates that the tectonic movements are mainly due to the expansion of the earth's interior, and that the folded mountains are due to the pressure exercised by the expanding core against the rigid earth's crust. Many other tectonic hypotheses have been proposed and demolished.

The remaining articles deal with the progress made in engineering geology, applied geophysics, the study of permanently frozen ground, the study of coal, oil shales and oil, and geography. Particularly interesting are articles describing the two new geological museums: the Chernyshev Central and Prospecting

Museum at Leningrad, opened in 1931 and containing collections illustrative of the progress of the geological survey of the U.S.S.R.; and the Karpinsky Geological Museum at Moscow, opened in 1934 and containing 72,250 specimens of minerals. These are arranged in five separate collections: systematic, geochemical, genetic, crystallographic and applied. Another interesting aspect of the status of geology in the U.S.S.R. is the establishment in 1920 of the Ilmen National Park in the southern Urals for the preservation and study of the famous mineral localities of precious stones and other minerals as well as flora and fauna.

The progress made in the U.S.S.R. in the utilization of mineral wealth is described independently in a short article by V. I. Kryzhanovsky[2], in which he gives a review of the achievement in the exploration and utilization of various ores. Only a few outstanding examples can be given here: the discovery of very rich iron ore at Magnitogorsk in the southern Urals, nickel and titanium in the southern Urals and Kola peninsula, molybdenum and tungsten ores in Siberia and Central Asia, bauxite at Tichvin (near Leningrad) and the Urals, tin ore (previously unknown in the U.S.S.R.) in Central Asia. There is also a description of the progress made in the prospecting and mining of gold, platinum, uranium, radium, manganese, coal and oil, borates, etc. But probably the most spectacular discoveries are those of apatite in the Kola peninsula and potash salts in the Urals, both of them of great importance in agriculture. The apatite deposits of the Kola peninsula, discovered in 1921, are the richest in the world, with an estimated reserve of 2,000 million tons. Since this discovery, a new industrial area with two new thriving towns has sprung up in a previously deserted arctic tundra. Besides apatite, a number of other minerals were discovered in the Kola peninsula, such as nepheline, pyrrhotite, titanium ores, ores of rare elements, kyanite, garnet, etc.

The discovery of potash salts at Solikamsk in the northern Urals is no less spectacular. The reserves of sylvite at Solikamsk are estimated to be five times greater than those at Stassfurt in Germany, hitherto regarded as the richest deposit in the world, and still more deposits are being discovered as the survey progresses.

The mineral wealth of the U.S.S.R., always known to be enormous, is rapidly coming within reach of the miner and thus provides a solid foundation for an ever increasing industrialization. The contributions made by geologists and miners to the defence of their country are thus inestimable. S. I. TOMKEIEFF.

[1] "The Progress of Geological and Geographical Sciences in the U.S.S.R. during Twenty-five Years". In Russian. Edited by V. A. Obruchev. (Moscow-Leningrad: Academy of Sciences of the U.S.S.R., 1943.)

[2] Kryzanovsky, V. I. "Les fossiles et la defence de l'URSS", *Bull. Acad. Sci. URSS.*, Ser. Geol., No. 6, 3 (1941).

## CHEMISTRY IN RELATION TO MEDICINE

IN a recent lecture before the Royal Institute of Chemistry* on some recent advances in chemistry in relation to medicine, D. H. Hey gives an interesting and concise account of the astonishing contributions which have been made in this field during the last ten years. The beginning of this century saw the introduction of the first therapeutic compound of major importance which had been made to the chemist's design, namely, aspirin, first made in 1899. At the present rate of progress, Dr. Hey suggests, the present major diseases and scourges of mankind will be completely controlled well before the end of this century. This will seem to some medical men an optimistic prophecy; but certainly recent work gives every reason to hope for its realization. One difficulty, however, is that the human talent which slays these dragons so rapidly discovers almost as quickly new causes of disease which defeat existing remedies; and although we may banish the major scourges, we should give equal attention to the minor ones, some of which cause incalculable unhappiness and economic loss and are untouched by our most efficient therapeutic compounds—the 'common cold', for example.

Dr. Hey deals with the sulphonamides, the amidines, the antibiotics (such as penicillin) and the steroid hormones (testosterone, œstradiol and progesterone). "It is no exaggeration to say that the new sulphonamide derivatives prepared during the last seven or eight years can be numbered by the thousand, but the vast majority of these have never been tested *in vivo*". The author explains how the chemist has juggled with the sulphonamide hydrogen atoms in the sulphonamide molecule to produce sulphapyridine, sulphathiazole and other compounds which are now being widely used, and he discusses the properties and bacteriostatic actions of these.

The history of the development of the amidines illustrates the tortuous paths by which final success is sometimes attained. Hey traces the origin of the work on the amidines to an early observation by Koch on parathyroid tetany. Methylguanidine was found in the urine of animals suffering from this, and it was found that administration of methylguanidine or of guanidine caused a fall in blood sugar. Guanidine compounds of greater activity but less toxicity were then sought out, and synthalin and synthalin B were introduced for the oral treatment of diabetes; but they caused too much damage to the liver. It was also found that trypanosomes consume, in artificial cultures, large quantities of glucose, and it was hoped that synthalin, by reducing the blood sugar, would interfere with the development of the trypanosomes and so would be useful for the treatment of sleeping sickness. Lourie and Warrington Yorke found that it did affect the trypanosomes, but not because it reduced the blood sugar but because it was trypanocidal, while insulin was not. This led to the discovery of less toxic drugs of this type, some of which have been tried for the treatment of trypanosomiasis and also, by virtue of their antibacterial action, for the treatment of burns and wounds. *The Lancet* (796, June 17, 1944), for example, discusses the use of propamidine (4 : 4′-diamidinodiphenoxypropane) for the treatment of sepsis in burns and wounds, pointing out that the work of F. R. Selbie and J. McIntosh (*J. Path. and Bact.*, 55, 477; 1943) and of J. W. Allen, F. Burgess and G. R. Cameron (*ibid.*, 56, 217; 1944) and of others indicates that the toxicity of this drug requires care in its use and selection of suitable cases. *The British Medical Journal* (725, May 27, 1944) discusses the relative advantages and disadvantages of the diamidines and antimonial compounds for the treatment of kala-azar and gives further references to the literature about them.

* "Some Recent Advances in Chemistry in Relation to Medicine". By Dr. D. H. Hey. Pp. 24. (London: Royal Institute of Chemistry, 1944.)

The blood anti-coagulants heparin and dicoumarin provide an equally interesting story. People receiving large and continued doses of salicylates should also receive vitamin $K_1$ or some related compound which will, by maintaining the synthesis of prothrombin in the blood, counteract the anti-coagulant action of salicylic acid due to its reduction of prothrombin. The fact that dicoumarin can be degraded to salicylic acid completes the story.

The author's treatment of the genital hormones is no less interesting and illuminating. The diagrams of the molecular structure of the compounds described help the inexpert reader very considerably.

G. Lapage.

## RADIO PLANNING IN THE U.S.A.

The present War has been accompanied by great advances in the application of radio technique to communications and other purposes, and much thought is already being given to the conversion of the results of this work to peace-time conditions. Among the major problems of a post-war world will be the allocation of different portions of the radio-frequency spectrum among the various interests involved, and the consideration of the trend of broadcasting with both amplitude and frequency modulation, and of television. In the United States of America, the body responsible for frequency allocation and for controlling the standards used in the systems developed for the various radio services is the Federal Communications Commission; and in November 1942 the chairman of the Commission, Mr. J. L. Fly, suggested that an organization representative of the radio industry and of the personnel involved therein might be set up to consider the technical requirements of the future in the field of radio. Accordingly, a Radio Technical Planning Board (R.T.P.B.) was set up during 1943; and an account of the organization and work of this body to date has been given by its chairman, Dr. W. R. G. Baker, in the June issue of the *General Electric Review* (U.S.A.).

The objectives of the Board are stated to be the formulation of sound engineering principles and the organization of technical facts which will assist in the development, for the public interest, of the radio industry and the radio services of the nation. The sponsors of the Radio Technical Planning Board are those non-profit-making associations and societies which have an important interest in radio and which indicate a willingness to co-operate in achieving the objectives of the Board. At the present time, there are twelve such bodies which contribute an annual sum of 1,000 dollars or more towards the expenses of the Board, while in addition, there are six non-contributing sponsors.

The article referred to above contains an illustrated detailed account of the organizational structure of the Board and its constituent panels, involving a total personnel of about six hundred at the present time. Under the staff and administrative committee, thirteen panels have been set up to deal with subjects covering the whole field of radio communication, broadcasting, television, facsimile, navigation and the use of high-frequency equipment for industrial, medical and scientific purposes. Each panel is under the chairmanship of a leading engineer in the particular branch of radio concerned, and he is assisted by the most competent specialists available.

An illustrated coloured chart accompanying the article shows that the frequency spectrum with which the Radio Technical Planning Board is concerned extends from 40 kilocycles per second to at least 500 megacycles per second. In view of this broad field, and the number of individuals involved, it is perhaps unlikely that there will be a preponderance of unanimous recommendations emanating from the work of the Board. Even in the absence of very many strong majority proposals, it is considered that the work of the Board will serve a useful purpose in bringing to light many controversial points and in amassing and disseminating a large amount of technical data and information which will be of undoubted value in the planning of radio applications after the War.

## THE NILE BASIN

In recent years the Egyptian Government has published various monographs dealing with the Nile and its waters, including Dr. J. Ball's "Contributions to the Geography of Egypt". Now Dr. H. E. Hurst, director-general of the Physical Department, has compiled a general non-technical account of what is known of the Nile basin and the floods of the Nile, as well as an account of the various barrages*. The publication is well illustrated by one coloured and several black and white maps and diagrams. There is, however, no bibliography.

The Nile basin, embracing about one tenth of the area of Africa, extends far beyond the confines of Egypt; but its most important aspects are peculiar to Egypt and the Anglo-Egyptian Sudan. A brief historical survey might perhaps have stressed how near the truth Ptolemy came regarding the sources of the Nile, though he was largely discredited until the end of the nineteenth century. The physical history of the river is sketched and Ball's hypothesis of Lake Sudd is discredited. The discovery of flint implements a few metres above the present level of the river at Khartoum is a blow to the theory of a lake which existed until a late date, when it was supposed to have overflowed to the north and joined the Bahr-el-Jebel and Blue Nile waters to the Nile. The distribution of early implements suggests that the stone people of the Nile valley probably lived in a warm and humid climate. Since that climate changed to its present character, Dr. Hurst believes that there is no evidence of periodic changes, though there are irregularities from year to year. Nor does he find any connexion, which has been suggested, between sunspot activity and Nile flow or the level of Lake Victoria.

While the hydrology of the Nile is fairly well known, there is still a little uncertainty about the origin of the rainfall which causes the floods. Abyssinia provides 84 per cent of all Nile water and 70 per cent of flood water; but the old theory that this water originates from the Indian Ocean monsoon seems to be fallacious. Rainfall on the east and south of the Abyssinian plateau is scanty compared with that on the west, to which, in the flood season, the winds blow across Africa from the Gulf of Guinea. It seems

* Ministry of Public Works, Egypt: Physical Department Paper No. 45. A Short Account of the Nile Basin. By Dr. H. E. Hurst. Pp. iv+77+9 plates. (Cairo: Government Press, 1944.) P.T.40.

probable therefore that the flood waters which irrigate Egypt originate in the Atlantic. The small contribution which the rain of the Lake Plateau makes to the Nile flow is put at about 16 per cent of the total flow. The Blue Nile is the great feeder, but the importance for this river of Lake Tana has been exaggerated; other tributaries are more important than the one draining Tana. The waters of the White Nile are dammed up by those of the Blue Nile when the latter is in flood, and much of the White Nile waters then, as at other times also, is lost by evaporation.

Dr. Hurst concludes with some suggestions for improving control of the river. The amount of water lost by evaporation in the Bahr-el-Jebel swamps is enormous. Possible ways of preventing this loss are either by the embankment of the Jebel and the Zeraf to prevent the spilling of water into the marshes, or the construction of a new straight channel outside the swamps into which the flow could be diverted. The loss of water on the Bahr-el-Ghazal Basin also calls for preventive measures. There is also the problem of constructing a dam below Lake Albert in order to use that lake as a storage reservoir. Another among the schemes touched on is the proposal for a power-station at the Aswan Barrage.

## PROCEEDINGS OF THE ZOOLOGICAL SOCIETY OF LONDON

IN the current number of the *Proceedings of the Zoological Society*, comprising Parts 1 and 2 of Volume 114, the division into two series (A and B) has been discontinued. Accordingly, all papers will now be published in a single annual volume, containing four parts. The issue of the *Proceedings* in three series, (A) General and Experimental, (B) Systematic and Morphological, and (C) Abstracts of papers communicated at the scientific meetings, was introduced in 1937, and at the same time the practice of giving a serial number to each volume. Previously the volumes were referred to only by the year of issue, which occasionally introduced some uncertainty about the date of publication, since the last part of the volume for any particular year might not appear until January or February in the following year. A further complication arises as a result of the large number of pages contained in the *Proceedings* of some particular years, which necessitated their being bound in two volumes, and title pages and contents sheets were supplied for this purpose. It thus became necessary to refer to the first or second 'volume' of each year of issue. The use of a serial volume number, which will be printed on all future parts, will obviate this necessity, and simplify bibliographic references to publications in the *Proceedings*.

The present number comprises ten papers dealing with a wide variety of subjects. F. W. Rogers Brambell has a paper on the reproduction of the wild rabbit, *Oryctolagus cuniculus* (L.), based on the examination of 957 males, 1,529 females and 1 inter-sex, obtained in Caernarvonshire between February 1941 and June 1942. A very interesting problem arises in connexion with the pre-natal mortality. It is estimated that at least 60 per cent of litters conceived are lost owing to the death and reabsorption of all the embryos, the majority of which die on or about the twelfth day. The mean number of young born to each adult female is found to be between 10·35 and 11·70 per annum. Ti-Chow Tung and Yu Fung-Yeh Tung give an account of experiments supporting their view that in the goldfish, *Carassius auratus*, there exists some centre comparable to the amphibian grey crescent from which the organizer region later arises. R. I. Pocock discusses the races of the North African wild cat. E. J. Popham describes the changes in an aquatic insect population produced by using minnows as predators. A significant difference between the population of three Corixids collected each week was observed, and after the introduction of the minnows the relative proportions of Corixids adapted to the background increased. Robert Gurney deals with the systematics of the crustacean genus *Callianassa*, and G. H. Findlay describes the development of the auditory ossicles in the elephant shrew, the tenrec and the golden mole. G. P. Wells has a paper emphasizing the inadequacy of our knowledge of even the commonest laboratory animals. The neuropodia and notopodia of *Arenicola marina*, L., are described in detail, and for working out the anatomy of the intricate musculature the use of polarized light is recommended. L. S. Ramaswami gives an account of the heart and associated vessels in some genera of *Apoda*, and V. V. Tchernavin gives a revision of the subfamily Orestiinæ and a revision of some Trichomycterinæ, including descriptions of new species based on material preserved in the British Museum, a great part of which was collected by the Titicaca Expedition, of the species of these little-known groups of freshwater fishes.

## RUSTY WATER AND MOSQUITO BREEDING

WE have received a report by Mr. K. B. Williamson, malaria research officer, Penang (c/o Ross Institute of Tropical Hygiene, London School of Hygiene and Tropical Medicine, W.C.1), on an "Investigation of Ferruginous Waters in relation to the Breeding of Malaria-carrying Mosquitoes". It is a common observation among malariologists in the tropics that waters containing rusty deposits or bearing iridescent surface films of precipitated iron are generally free from mosquito larvæ, and the possibility of utilizing this fact for the control of mosquito breeding has often been mooted. But exact information about the composition of waters of this kind and about the source of the iron has been wanting. Mr. Williamson's report is based on the examination of various types of rusty waters on Hampstead Heath and elsewhere in the neighbourhood of London and around Malvern, as well as upon his experiences in Malaya. It deals mainly with questions of chemistry.

Iron occurs in water: (1) in particulate form as colloidal ferric hydroxide ('iron rust'), the particles being so small that the water is quite clear; it is this colloidal iron which is unstable and readily gives rise to solid aggregates in the form of surface films or precipitates; (2) in true solution as ionized salts of ferrous or ferric iron; (3) as non-ionized organic complexes.

The humic matter derived from the slow rotting of excess vegetation present in soil combines with both ferrous and ferric iron and exerts a stabilizing influence on the colloidal ferric oxide. Humic matter is itself antagonistic to the breeding of most species

of malaria-carrying mosquitoes. Excess of rotting vegetation in contact with the soil will thus exert a dual benefit.

A provisional attempt has been made to classify ferruginous waters. A ferruginous water is defined as one that contains a minimum of two parts per million of iron in solution or colloidal suspension. Many so-called 'rusty' waters show merely a deposit of rust-coloured sediment which has been thrown down at an earlier date; a deposit of this kind affords no proof that the water continues supercharged with iron. On the other hand, superficial films of 'rust' supply a more immediate indication of the presence of an unstable excess of iron in water. Such iron may be derived (i) from underground mineral sources such as pyrites, (ii) from vegetation rotted under anaerobic conditions in marshy soil, the iron-containing humus forming organic complexes with the iron present in the superficial soil, or (iii) in small amount, from the rotting of vegetation alone in the water.

On the biological side the work is incomplete. Observations on the natural fauna and flora of ferruginous waters have been rather limited; but such waters are characterized by an almost complete absence of water insects, aquatic helminths, Crustacea and Algæ. It has been found by experiment that mosquito larvæ (*Anopheles maculipennis* var. *atroparvus*), newly hatched from the egg, are unaffected by the iron-containing waters provided they are fed; but when placed in samples of such waters without added food they soon die of starvation. It is, therefore, concluded that mosquito larvæ fail to develop in rusty water from lack of food, which is ascribed in the main to the inimical effects of colloidal iron upon the growth of Algæ, Protozoa and other micro-organisms. There is no evidence that iron-containing surface films will suffocate the larvæ.

## FUEL RESEARCH

THE Melchett Lecture for 1944 of the Institute of Fuel was delivered on October 12 by Dr. J. G. King on the "Pattern of Fuel Research". Under this title he gave an account of the progress of fuel research seen as a whole, with main branches and subsections fitting together into patterns although the work may have been done in many places, by various organizations and individuals.

The three main patterns chosen were the hydrogenation, the gasification and the study of the constitution and properties of coal. Dr. King gave a survey of the development, from the first observations of Bergius in 1912, of the hydrogenation of solid coal, of the liquid products of carbonization and of petroleum. Actually the conversion of solid coal to liquid fuels ranging from heavy oil to light spirits and hydrocarbon gases involves an interwoven sequence of stages. Behind the large-scale operations now in use stands an immense volume of patient experiment to fix the choice of catalysts, temperature, pressure and other conditions necessary for success, some of which has been done at the Fuel Research Station under Dr. King's direction.

The carbonization of coal in ovens or retorts carries the limitation that only about one fourth of the raw coal can be recovered in the gaseous form. By gasification in the gas producer, it is possible to recover nearly all the fuel in a fluid form but unsuitable for public supply. It came to be recognized that by substituting oxygen for air and working at pressures above atmospheric, the products of gasification could be modified in chemical composition to give a product more suited for public distribution. It happens that in our generation, the technique of oxygen production has so developed as to make it possible to use oxygen in fuel manufacture—at least in some countries. In Great Britain the Joint Research Committee of the Institution of Gas Engineers and the University of Leeds has pursued the problems involved for nearly ten years. It is found that a range of technique is possible, from direct hydrogenation of coal to methane, reaching to a synthesis of methane from the product of pre-gasification of coke by oxygen and steam. These investigations are now in the stage of large-scale operation. In the long run, the successful achievement of this part of the pattern of fuel research can have far-reaching effects.

Dr. King's third main branch of the pattern covers the study of coal constitution and properties both physical and chemical. This includes the immense volume of work done in laboratories all over the world. It would appear that the results of this work, though marked often by ingenuity and industry, have been, in the main, of academic value only, and no clear pattern is revealed. It is thus unlike the first two branches, which concern themselves with the developments of processes. The study of constitution and properties must, however, be of assistance to them.

Dr. King's lecture can be commended as an excellent picture of the pattern of current research on fuel.

## FORTHCOMING EVENTS

### Saturday, December 2

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES' BRANCH) (at the Royal Institution, Albemarle Street, London, W.1), at 2 p.m. —Conference on "The Selection and Training of Personnel for Industry" (to be opened by Major F. A. Freeth, F.R.S.).

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. G. M. Lees: "The Geology of the Oilfields of the Middle East".

SHEFFIELD METALLURGICAL ASSOCIATION (joint meeting with the IRON AND STEEL INSTITUTE and the SHEFFIELD SOCIETY OF ENGINEERS AND METALLURGISTS) (at the Royal Victoria Station Hotel, Sheffield), at 2.30 p.m.—Discussion of Papers presented to the Iron and Steel Institute.

### Monday, December 4

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. S. K. Kon: "Milk", (3) "Milk in relation to Human Nutrition—Recent Aspects" (Cantor Lecture).

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W.C.2), at 2.30 p.m.—Mr. H. R. Davidson: "Pigs in the Long Range Policy".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S.W.7), at 5 p.m.—Dr. J. K. St. Joseph: "Air Photography in Archæology".

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. E. S. Waddington: "The Welding of Aluminium"; Dr. H. G. Taylor: "Light Alloy Welding".

### Tuesday, December 5

ROYAL ANTHROPOLOGICAL INSTITUTE (at the Royal Geographical Society, Kensington Gore, London, S.W.7), at 1.30 p.m.—Mrs. Olive Murray Chapman: "A Journey across Madagascar".

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Mr. W. C. Cooper: "The Classification and Indexing of Technical Aeronautical Information"; Dr. J. A. Wilcken: "Abstracting, Indexing and Classification".

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 5.15 p.m.—Sir Henry Dale, O.M., G.B.E., Pres.R.S.: "Modern Developments in Chemical Therapeutics", (i) "Beginnings of Chemotherapy".

INSTITUTION OF CIVIL ENGINEERS (STRUCTURAL AND BUILDING ENGINEERING DIVISION) (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Prof. A. J. Sutton Pippard and Letitia Chitty: "Some Problems presented by Cable Bracing".

QUEKETT MICROSCOPICAL SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Exhibits.

### Wednesday, December 6

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. C. A. P. Southwell: "Petroleum Production in England".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 2.45 p.m.—Dr. George Martin Lees: "The Geology of the Oilfields in Great Britain".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Scientific Papers.

ROYAL ENTOMOLOGICAL SOCIETY OF LONDON (at 41 Queen's Gate, South Kensington, London, S.W.7), at 3.30 p.m.—Dr. C. B. Williams: "A Recent Entomological Tour of South America on behalf of the British Council".

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. L. Essen: "The Measurement of Balanced and Unbalanced Impedances at Frequencies near 500 Mc/s and its Application to the Determination of the Propagation Constants of Cables".

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (joint meeting with the KINEMATOGRAPH SECTION and the BRITISH KINEMATOGRAPH SOCIETY) (at 16 Princes Gate, South Kensington, London, S.W.7), at 6 p.m.—Discussion on "Photographic Aspects of Sound Recording".

### Thursday, December 7

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 2.30 p.m.—Prof. James Gray, F.R.S.: "Locomotory Mechanisms in Vertebrate Animals", (iii) "Locomotory Mechanism in Typical Tetrapods—Limbs as Co-ordinated Struts and Levers".

CHEMICAL ENGINEERING GROUP (joint meeting with the INSTITUTION OF CHEMICAL ENGINEERS and the BRISTOL SECTION OF THE SOCIETY OF CHEMICAL INDUSTRY) (in the University Chemical Department, Woodland Road, Bristol), at 5.30 p.m.—Mr. R. T. Pemberton: "Ion Exchanges Applied to Water Treatment".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. G. A. Juhlin: "Standardization and Design of A.C. Turbo-Type Generators".

### Friday, December 8

ASSOCIATION OF APPLIED BIOLOGISTS (at the Imperial College of Science, South Kensington, London, S.W.7), at 11.30 a.m. (in the Botanical Lecture Theatre)—Mr. T. Goodey: "Eelworm Disease of Onions—Some Recent Investigations"; at 2.15 p.m. (in the Metallurgical Lecture Theatre)—Mr. F. R. Petherbridge: "The Biology and Control of the Carrot Fly"; Mr. A. Roebuck: "The Carrot Fly in the Midlands"; Mr. G. Fox-Wilson: "Investigations into the Control of the Carrot Fly under Garden Conditions".

INSTITUTE OF FUEL (SOUTH WALES SECTION) (at the Engineers' Institute, Cardiff), at 4.30 p.m.—Mr. J. O. Samuel: "The Application of Flocculation and Flotation Principles to the Recovery of Low Grade Fuel".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Discussion on "Astronomical and Geophysical Periodicities" (to be opened by Dr. Harold Jeffreys, F.R.S.).

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 5 p.m.—Lieut.-Colonel E. F. W. Mackenzie: "London's Water Supply—Safeguarding its Purity in Peace and War".

### Saturday, December 9

BRITISH MYCOLOGICAL SOCIETY (in the Department of Biology, Chelsea Polytechnic, Manresa Road, London, S.W.3), at 12 noon.—Annual Meeting; at 2 p.m.—Mr. R. W. Marsh: "Mycological Contacts".

### Saturday, December 9—Sunday, December 10

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX (at the Royal Society, Burlington House, Piccadilly, London, W.1).

**Saturday, December 9**

At 11.30 a.m.—Sir Frederic Kenyon, G.B.E., K.C.B.: "Organized Knowledge in the World of the Future".

At 2 p.m.—Symposium on "The Empire Contribution to the Flow of World Information".

At 4.30 p.m.—Mr. G. K. Wilkie: "Trade Catalogues in Commercial Libraries".

**Sunday, December 10**

At 11 a.m.—Mr. Geoffrey A. Shires: "The Technical Information Bulletin and What to Put In It": Mrs. Lucia Moholy: "Developments and Extensions in the Use of Microfilm".

At 3 p.m.—Discussion on "The Status and Education of Special Librarians and Information Officers".

At 5 p.m.—Mr. B. Agard Evans: "Some Aspects of a New Technical Information Service in War-time".

## APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

EDUCATIONAL PSYCHOLOGIST—The Director of Education, County Offices, Oxford (December 8).

SPEECH THERAPIST (full-time)—The Chief Education Officer, County Offices, Chelmsford (December 8).

LECTURER (full-time) IN ELECTRICAL ENGINEERING—The Principal, Technical College, Bradford Place, Walsall (December 9).

ASSISTANT MASTER (full-time) to teach Mechanical Engineering Subjects in the Day School of Engineering and the part-time Day and Evening Engineering Courses—The Principal, Hendon Technical College, The Burroughs, Hendon, London, N.W.4 (December 9).

LECTURER (full-time) IN PHYSICS to B.Sc. Special standard—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex (December 9).

DEPUTY BOROUGH ELECTRICAL ENGINEER—The Borough Electrical Engineer, Electricity Showrooms and Offices, 197–199 Chiswick High Road, London, W.4 (December 11).

ASSISTANT (full-time) to teach ENGINEERING Subjects in the Stockton-on-Tees Technical School and Evening Institute—The Director of Education, Shire Hall, Durham (December 11).

ASSISTANT LECTURER IN PHARMACEUTICAL CHEMISTRY in the Chemistry Department, and a LABORATORY STEWARD IN THE DEPARTMENT OF ZOOLOGY—The Registrar, University College, Nottingham (December 11).

SIBTHORPIAN PROFESSORSHIP OF RURAL ECONOMY—The Registrar, University Registry, Oxford (February 24).

LECTURER IN GEOGRAPHY—The Secretary, The University, Aberdeen (March 31).

ASSISTANT IN THE BOROUGH ANALYST'S DEPARTMENT—The Town Clerk, Town Hall, Burnley, Lancs. (endorsed "Assistant, Analyst's Department").

LECTURER IN THE APPLIED CHEMISTRY DEPARTMENT—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

TEACHER (experienced and well qualified) OF MATHEMATICS AND SCIENCE—The Principal, Technical Institute, Darnley Road, Gravesend.

DEPUTY LIBRARIAN in scientific library—The Secretary, Geological Society of London, Burlington House, Piccadilly, London, W.1.

HEAD OF THE BOTANICAL ECOLOGICAL SECTION—The Secretary, Scottish Seaweed Research Association, Ltd., 28 Rutland Street, Edinburgh 1.

PHYSICAL CHEMIST, a BIOCHEMIST, and two TECHNICAL ASSISTANTS—The Director, Cereals Research Station, Old London Road, St. Albans.

## REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

### Great Britain and Ireland

Transactions of the Royal Society of Edinburgh. Vol. 61, Part 1, No. 8: The Petrography of the Franz Josef Fjord Region, North-East Greenland, in relation to its Structure; a Study in Regional Metamorphism. By Dr. N. E. Odell. Pp. 221–246+4 plates. 8*s.* 6*d.* Vol. 61, Part 1, No. 9: The Cephalopoda of Scottish and Adjacent Waters. By Dr. A. C. Stephen. Pp. 247–270. 6*s.* (Edinburgh and London: Oliver and Boyd.) [1210

Post-War Forestry. A Report on Forest Policy prepared by the Royal Scottish Forestry Society and the Royal English Forestry Society. Pp. 62. (Edinburgh: Royal Scottish Forestry Society; London: Royal English Forestry Society.) [1710

Edinburgh and East of Scotland College of Agriculture. Calendar for 1944–1945. Pp. 58. (Edinburgh: Edinburgh and East of Scotland College of Agriculture.) [1710

British Rubber Producers' Research Association. Publication No. 50: The Molecular Weights of Rubber and related Materials, 5: The Interpretation of Molecular Weight Measurements on High Polymers. By G. Gee. Pp. 6. Publication No. 51: The Course of Autoxidation Reactions in Polyisoprenes and Allied Compounds, Part 8: The Photo-Oxidation of Methylelaidate, by Donald A. Sutton; Geranylamine, by Donald A. Sutton. Pp. 4. Publication No. 52: On the Calculation of Certain Higher-Order Bethe Approximations. By W. J. C. Orr. Pp. 28. (London: British Rubber Producers' Research Association.) [1710

### Other Countries

South African Institute for Medical Research. Annual Report for the Year ended December 31st, 1943. Pp. 47. (Johannesburg: South African Institute for Medical Research.) [189

U.S. Office of Education: Federal Security Agency. Vocational Division Leaflet No. 14: Teachers are Needed. By Walter J. Greenleaf. Pp. ii+26. (Washington, D.C.: Government Printing Office.) 10 cents. [209

New Zealand. Eighteenth Annual Report of the Department of Scientific and Industrial Research. Pp. 58. (Wellington: Government Printer.) 1*s.* 3*d.* [229

Victorian Bush Nursing Association. 32nd Annual Report and Statement of Accounts to 30th June 1943. Pp. 158. (Melbourne: Victorian Bush Nursing Association.) [310

U.S. Department of Agriculture. Circular No. 702: Productive Management of Honeybee Colonies in the Northern States. By C. L. Farrar. Pp. 28. (Washington, D.C.: Government Printing Office.) 10 cents. [510

Field Experiments on Sugar Cane in Trinidad. Annual Report for 1943. Pp. 202. (Trinidad: Government Printer.) [610

Sudan Government. Wellcome Chemical Laboratories, Sudan Medical Service, Khartoum. Report of the Government Analyst for the Year 1943. Pp. 8. (Khartoum: Wellcome Chemical Laboratories.) [610

Les nouvelles méthodes insecticides et les épidémies. Par A. L. Lepigre. Pp. 14. (Alger: Centre National de la Recherche scientifique.) [610

### Catalogue

D.D.T.: a Review. By Dr. V. H. Chambers, G. L. Hey and N. K. Smitt. Pp. 24. (Wheathampstead: The Murphy Chemical Co., Ltd.)

# NATURE

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CONTENTS




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## PROFESSIONAL INSTITUTIONS

IN an important passage in its statement on "Scientific Industrial Research", Nuffield College directs attention to a problem arising out of the use of university laboratories or research workers for applied research. The suggestion is made that if there were a code of conduct recognized as generally applicable to university scientific workers undertaking outside industrial work for private firms, it would be a comparatively easy matter to work out a special code to cover these problems so as to avoid alike restrictive conditions, on either side, slackening in the pursuit of science, or undue influence over university departments by particular firms or industries. Obviously, as the memorandum indicates, the entire problem is one to be tackled jointly by the universities, professional associations and industrialists, and it is one in which the initiative might be expected to come from the professional associations of scientific workers themselves.

This is a particular example of the kind of contribution which Prof. Carr-Saunders and P. A. Wilson visualized professional associations making to the development and welfare of society in their study some twelve years ago of the professions. It is of more interest since there have in the interval been so few signs that professional associations are aware of the immense opportunities before them in this connexion, or how great could be their contribution to the reconstruction of the crumbling or broken fabric of democratic life. Without their advice and co-operation, the right atmosphere and the appropriate conditions for fruitful research may be difficult to attain; and there are other fields in which the professional contribution may be equally invaluable. As Carr-Saunders and Wilson noted, it is not that professional men are innately reactionary or unprogressive, but that they lack vision. "They do not grasp the essential features of the social and economic structure and the place of the professions in it. Moreover in so far as they do interest themselves in matters outside the development of their own technique, they often fail lamentably to display the same standards of exactitude and judgment as they demand with vigour in their immediate spheres. The pity of it is that their opportunities are so great and that they have so large a part to play, if only they would open their eyes and summon up courage to act in the large issues of contemporary life."

Despite honourable exceptions, it cannot well be said that that criticism is any the less true than when it was written, nor has there been any notable progress in the study of the urgent problem of proper relations between professional associations, as repositories of specialized knowledge, and the democratic State. We cannot reasonably claim that, despite the enhanced importance of planning, much obvious thought has been given to the problem of the methods which professional associations should employ to present their views and which the State should use to obtain their advice. The organization outlined early this year in the White Paper on Scientific Research and Development has grown almost

haphazard, but it at least meets the essential criteria of Carr-Saunders and Wilson that there should be many channels of communication between knowledge and power, that they should be kept wide open, that proposals and criticisms should be freely circulated and that the mechanism should be flexible and capable of easy adaptation as circumstances demand.

That organization, however, scarcely provides for adequate consultation or representation of professional associations, whose representations are sometimes more effectively made through the Parliamentary and Scientific Committee. Its emphasis is rather on the individual expert than on his professional association, and therein lies a great weakness. One function of the professions as such is to bring knowledge to the service of power but, as Carr-Saunders and Wilson point out, that function is, and can only be, effectively discharged when men and women, finding in vocational associations their permanent anchorage and shelter, set out from these secure positions to shape organizations into instruments for the fulfilment of their social and economic purposes. Unless that is done, the organizations set up to enable men and women to perform their special service in the ordinary business of life escape from control and become a menace both to professional efficiency and to social progress and well-being.

That contribution is the more important if we consider, as Prof. H. J. Laski argues in his "Reflections on the Revolution of our Time", that the present fleeting opportunity of revolution by consent, and of experimenting with the conditions which make possible the resumption of expanding welfare, involves putting the idea of freedom in the context of equality, and discovering exactly how freedom and democracy interpenetrate one another. Post-war reconstruction and the fundamental adjustment of society to the changes in structure which the War has already brought about, offer a great and inescapable challenge to professional organization and thought. If professional men do not face the problem of reconciling freedom with power and responsibility, the prospects of winning the peace are indeed dark. To put professional advantage in face of public duty at the present time would be, in the end, fatal to their own interests. Collectively and individually, scientific workers can no longer live in their laboratories or professional associations as ivory towers: they are concerned with the social context of their work, and to see that social and political policy do not frustrate the quality or extent of their contributions to social well-being.

The chapter "Freedom in a Planned Democracy" in this same volume deserves close attention for its stimulating suggestions of the kind of contribution which trade unions and other professional associations might make in a new social order in which the concept and context of freedom are positive rather than negative. It is, in fact, this negative concept that has warped the activities of the trade associations and fostered restrictive practices, as it does in the professional field. In a new prospective in which that fear of want and insecurity is removed, professional associations will find their protective functions far less important than the contribution they can make to the improvement of the standards of professional practice, in science, in law, in medicine and in technology. Trade unions in such a context might well be set free from present inhibitions and take a fuller interest in the organization of industries in the interest of the community generally, the fostering of technical development and the support of scientific research.

These possibilities are at present scarcely glimpsed. The routines by which, as Prof. Laski rightly notes, men live have too often limited their professional horizon, and in an age of insecurity the threat to that routine has clouded their judgment. Again, arguing that the maintenance of democracy as a framework for the State is essential for the maintenance of free discussion and the spirit which scientific discovery requires, Prof. Laski maintains that a civilization at once so complex and so fragile as ours must postulate the need for scientific discovery as a primary condition of its survival. That effort, with all it means in scientific and industrial research, will demand, as we have so often urged in these columns, the widespread support and understanding of all sections of the community, and the importance of the contribution which the trade unions might make, given once a new outlook, is not easily overstressed.

The nature of the contribution of professional organizations to the social and economic structure has been further indicated by J. T. MacCurdy in a suggestive chapter in his little book "The Structure of Morale". One of the central problems of democracy is that of establishing a right balance between efficiency and liberty, and of providing effective means for discussion at the lower as well as at the higher levels. That is the importance of the production committees which the War has called into being; they may have a vital part to play in the fuller integration of industry with the community which its prime function is to serve.

The development of group loyalties in this way is of importance for two reasons. First, it encourages the expression of the ideals and experience of the individual, particularly of his creative powers, as Dubreuil has emphasized in his exposition of the idea of autonomous groups in industry. Secondly, it facilitates that contact between the upper levels of the hierarchical organization required for large-scale planning and the accurate and detailed knowledge based on experience at the lower levels which is essential for flexibility and the modification of policy in the light of experience. Huge organizations, as MacCurdy notes, are necessarily inefficient owing to their rigidity and inadaptability; to fabricate a social organization that is really adaptable, we have first to develop a liaison system comparable in its intricacy with the individual human brain.

Some recognition of this is to be found in such reports as that of the Social and Industrial Commission of the Church Assembly on "The Church and the Planning of Britain"; but it is unfortunately true that professional organizations, like the trade unions themselves, which might be making an invaluable

contribution to the development of a liaison or intelligence system of the type required, are specially liable to this disease of ossification, rigidity and conservatism to which all large-scale organization seems to be a prey. A number of professional associations have, it is true, recognized their responsibilities in regard to reconstruction, either generally or in some special field. It was a major purpose, for example, of the Institution of Professional Civil Servants in submitting its proposals for the reconstruction of the technical Civil Service (see p. 743 of this issue of *Nature*) that the professional and technical services should thereby be better equipped to give the more positive services to the community that will be required of them. The Association of Scientific Workers has issued two admirable statements on "Science and the Universities" and "A Post-War Policy for Science". The Institution of Electrical Engineers has established a Post-War Planning Committee to study post-war developments in electrical engineering, with terms of reference which imply not merely important contributions to public policy but also consideration of desirable changes in the structure and machinery of the Institution.

Special contributions in the particular fields where they are qualified have been made by such bodies as the Association of Architects, Surveyors and Technical Assistants and, through its Reconstruction Committee and Architectural Science Group, the Royal Institute of British Architects. In this connexion the Modern Architectural Research Group and the Engineers' Study Group on Economics should also be mentioned. None the less, the essential danger remains. It can be seen in the general outlook of considerable bodies of scientific workers, and it has to be taken into account in considering any such proposals as those of the Royal Statistical Society for a supplementary charter enabling it to institute a professional diploma for statisticians with the view of raising their status. The rational approach is seen in Dr. Frans Verdoorn's address in the symposium on "Biologists and Rehabilitation" arranged by the Botanical Society of America and the American Association for the Advancement of Science at Cleveland on September 13 (see *Nature*, **154**, 595, 1944). Such an impartial and fundamental approach to questions of scientific co-operation, whether national or international, and especially in such matters as publications, is all too rare.

What is required is, in fact, exactly such a reconsideration of the position and functions of professional bodies in relation to society against the background we have indicated, and with particular references to the inherent weaknesses of all such associations. This outlook is hard to find in the only recent survey of professional associations in the scientific field—a brief memorandum "The A. Sc. W. and Other Bodies", issued by the Association of Scientific Workers. Here once again the approach is subjective and functional; but the memorandum clearly indicates the need for rationalization, which some of the large bodies of scientific workers, such as the chemists, have refused to face. The memorandum may well serve as a starting point for further discussion of the whole subject. In particular, it may help to clarify some of the confusion in the public mind between the scientific or learned societies and the professional associations of scientific workers.

Broadly speaking, the professional associations with which scientific workers are concerned fall into three types according to their function. There are, first, the learned societies, concerned principally with the encouragement, discussion and publication of scientific research in particular fields. Headed by the Royal Society, they cover almost every subject, and it will be noted they are the oldest societies of scientific workers in existence.

The formation of these learned societies was followed at varying intervals by the establishment of organizations or institutes concerned with the maintenance of professional standards, first of qualifications and then of conduct or ethics. Some of them, like the Institution of Electrical Engineers, the Institution of Mechanical Engineers, the Institution of Civil Engineers, the Royal Institute of Chemistry and the Institute of Physics are chartered bodies and cover wide fields of pure or applied science. Other more recently established bodies such as the Textile Institute, the Institution of the Rubber Industry and Institution of the Plastics Industry are concerned with much more limited fields, and in activities, such as publications, overlap with the functions of the scientific societies.

The third and most recent type of professional association is what may be termed the defence organization concerned with the protection of the economic interests of qualified professional men, of which type the Association of Scientific Workers and the British Association of Chemists are the best known. Here again there is some overlapping, for so far as public analysts are concerned the Royal Institute of Chemistry has proved an effective defence organization and indeed was largely formed originally to promote the interests of the public analyst. Moreover, associations formed primarily for defence purposes have taken no narrow view of their functions and have often been as concerned to maintain standards of professional qualification as to protect the economic or professional interests of their members.

Apart from the confusion of functions, one of the weaknesses of the professional organization of scientific workers has been imperfect representation. Even some comparatively numerous bodies such as the Royal Institute of Chemistry with 9,000 members are not fully representative: there are, for example, some 20,000 names on the Chemical Section of the Central Register. Others, even when fully representative of the profession or technique, are numerically too weak, and efforts to redress numerical weakness by merging with other bodies or by lowering the standard of qualification are obviously detrimental alike to public and professional interest. For the chartered institutes to fulfil their primary functions it is imperative that they maintain uniform recognized levels of qualification, on the basis of which the profession can become a well-defined and coherent whole. These levels of qualifications must be recognized and

observed by the corresponding defence associations also: whatever measures are required to safeguard the interests of laboratory assistants, they emphatically should not include admission to the associations of fully qualified practitioners, however important it is that such associations should be closely concerned with the welfare and training of potential candidates. The Association of Scientific Workers shows a complete misconception on this point where its memorandum suggests that a grade of membership of the Royal Institute of Chemistry is required to cover the partly qualified assistant chemist or laboratory assistant.

Some rationalization of professional associations and societies is clearly desirable, particularly in regard to their practice in publication; but each of these three functions has its own contribution to make in bridging the gap between knowledge and power and furthering that intelligence system so essential in an effective democratic society. Moreover, the development of more effective organization for corporate representations, such as the Joint Council of Professional Scientists set up in 1942, may in time encourage such rationalization and the more effective use of available resources in publications and other matters. Again, the experience of some of the smaller societies such as the Oil and Colour Chemists' Association and the Society of Dyers and Colourists, particularly with their technical advisory panels, in assisting Government Departments in solving war problems, is of importance as indicating services which might be less easily rendered in a larger organization.

Rationalization of the associations of scientific and other professional workers can only be looked for when the point of view expressed so admirably by Carr-Saunders and Wilson permeates their councils and governing bodies and the members generally. When that time arrives, we may hope for a thorough and impartial scientific examination of the whole problem, and the outline of a plan unwarped by deference to the embedded prejudices or traditions to be found vested among scientific organizations as elsewhere. The report of the British Commonwealth Science Committee contained some concrete proposals on these matters to which there has been as yet little evidence of any general response. Meanwhile, the consciousness that effective post-war planning can only proceed as the appropriate means are found for science to make its contribution at the right stage may give a fresh impetus to the consideration of the organization of our scientific effort and the development of improved liaison between the Government and professional associations. Again, the acute difficulties in which scientific publications in Britain are now placed, partly as a result of the paper position, may induce fresh efforts to deal with the publication of scientific research and its exposition to industry and the general public on a more rational basis, and also with the vexed and difficult question of the abstracting of scientific and technical literature. Dr. Verdoon's suggestions on this point in regard to biological literature have a wider application and deserve note by scientific workers generally. The experience of the Joint Council of Professional Scientists may assist the development of new means of collaboration, but something more than organization will still be required. Without some wider vision and more urgent sense of professional responsibilities and of the possibilities and opportunities of public service, we cannot expect scientific workers and other professional men to take the first and most difficult step involved in scrutinizing anew their professional organizations in the light of the needs of the day and the fundamental principles and purposes they have to serve. Adequate organization is essential, but even more important is a high sense of public duty and the willingness to co-operate for constructive purposes. It is only when the threefold functions of professional associations are pursued co-operatively and in balance, and not to the nurturing of one at the expense of others, that professional men will play the essential part that is theirs in extending the empire of reason over the minds and habits of men, and replacing arbitrary discretion in any man or group of men by settled and agreed principles within the ambit of which their conduct must be controlled. On these two things, both fundamentally denied by Nazism and Fascism, civilization depends.

## GEOLOGY WITHOUT TEARS

**Principles of Physical Geology**

By Prof. Arthur Holmes. Pp. xii+532+95 plates. (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1944.) 30*s*. net.

A GEOLOGICAL author who introduces the word 'Principles' into the title of his work is wittingly inviting a comparison with Charles Lyell's masterpiece, "The Principles of Geology", which, more than a century ago, laid the foundations of the modern science. Whereas Lyell's was a work of genius, the present book is not; but this is no matter for the slightest regret. It may be debated whether geological science at this present time needs a genius or could make much of one were he to appear, but there can be no question at all that it needs an expositor—and here is one with a rare combination of lucidity and sprightliness. Geologists have wailed of late about the neglect of their science and of themselves in many fields both warlike and peaceful, and have traced this neglect to the ignorance of geology among all classes of the community in Great Britain and especially among those classes which should know better. Their laments have certainly been justified, but they have proposed few workable remedies. It seems that the cure has lain all the time in the hands of the geologists themselves; they cannot expect many people nowadays to struggle for knowledge, and they must accordingly make their wares attractive and take them to the customers. Here is a very attractive article indeed.

To begin with, the story of the development of the surface of the earth should interest everyone outside a penitentiary cell or a similarly secluded luxury flat, for the simple reason that we walk about on that surface, grow our food in it, get the raw materials of industry from under it and, in these days of so-called progress, dig a nice safe shelter deep below it. Apart from this, the story itself is exciting, with revolutions every so often, with the ceaseless interplay of varied

forces, with a little happening for a very long time and a lot happening in practically no time at all. As has been said already, Prof. Holmes displays these matters with complete clarity, and in an even and fluent style. Further, at this time of 'economy standards', it is sheer delight to read and handle a book printed in pre-war fashion on a white paper in a good type and with wide margins, and furnished with an abundance of excellent illustrations in plates and figures. There seems to be no reason why this book should not be a best-seller, and with much more justification than most.

The book is divided into three parts. The first, and least satisfactory, is an introduction to geology intended to equip the reader for a proper appreciation of the following two parts. To write a short account of the fundamentals of a science is a far more difficult job than to write a long account of its latest developments; by the same token, the ablest teachers should teach the elements of their science and leave the last graduate to retail competently the embellishments of his own times. This first part, and a very fundamental part it is, appears to have been insufficiently thought out. It seems unlikely to the reviewer that an ordinary intelligent non-geologist could make much of certain sections of it.

Parts 2 and 3, on the other hand, are excellent. The first of these deals with operations at the surface and gives an account of weathering and the sculpture of the lands by water, wind and ice. This part ends with modern statements on life as a rock-builder and as a fuel-maker, that is, on the rocks of organic origin, limestones and coals and petroleum. It may be remarked here that the author tends to suggest that all problems in geomorphology and surface activities generally have been solved; fortunately, this is by no means the case.

In the last section of the book, we get below the surface and are presented with an exciting account of internal processes and their results. Earthquakes and volcanic activity are dealt with in a competent, modern manner. The two styles of earth-movements, the orogenic or mountain-building and the epeirogenic or plateau-building, are described, the illustrative examples being so chosen that not only is the tectonic make-up of the continental masses summarized but also more detailed expositions of specially interesting units such as the African rifts, for example, are presented. The last chapter discusses the theory of continental drift. This section differs in tone from the previous one, in that it is now admitted that there are a great many problems still unsolved; but Prof. Holmes appears to suggest that solutions for most of these will eventually be found along the lines proposed by him. Thus, the notion of internal convection currents, elaborated by the author in recent years, is applied to account for mountain-building and for volcanic activity, and is used as the mechanism for continental drift. It is, of course, right and proper for a geologist or anyone else to have a profound belief in his own proposals, but this is no guarantee that the belief will be widely held by others. It would have been better and fairer for the general reader if some of the many other speculations on these topics had been mentioned, if not discussed.

In the estimation of a book of this calibre, minor criticisms—and many could be made—would verge on the pettifogging. There is one regrettable lapse that must be excised in a new printing; that fine Dartmoor tor at Manaton is disgraced by the title of the Mussolini Rock! In spite of minor defects that could easily be remedied, the book rises well above any recent work in English in its own field. It is to be hoped that the geological education of the community begun by this book will be continued in as pleasant a manner. H. H. READ.

## POPULATION GROWTH

### Plenty of People

By Warren S. Thompson. (Science for War and Peace Series.) Pp. x+246. (Lancaster, Pa.: Jaques Cattell Press, 1944.) 2.50 dollars.

"THIS book is an attempt to introduce the lay reader to the problems of population growth", says the preface. The author outlines—no more—the major economic, social, and military problems arising from populations either too big or too small for the areas which they inhabit. The fifteen chapters (or rather fifteen essays in random order) cover a world survey of population growth, with useful statistical material on birth- and death-rates, and a discussion of the relationship between population growth and age-composition, war, migration, international trade, and the treatment of minorities. A section on eugenics blames family environment rather than heredity for producing delinquent offspring from delinquent stock. Finally, the author describes existing population policies, particularly Germany's, and suggests a policy for the United States.

Dr. Thompson's book is on purpose thinly documented out of too much care for the lay reader. The most disquieting gap is the lack of any reference to Fru Myrdals' "Nation and Family", which deals more profoundly with a section of the ground covered here. Dr. Thompson could also have improved his presentation by tabulating statistics where possible instead of writing most of them into the text, and by eliminating repetition. However, these criticisms should not overshadow Dr. Thompson's basic achievement; he simplifies difficult problems without omitting major arguments, and he underlines the main points by excellent graphs and diagrams.

Dr. Thompson distinguishes two distinct stages in the development of population control. First, control of the death-rate. Secondly, control of the birth-rate. The period of greatest population growth occurs when a community has learned to control its death-rate, but has its birth-rate still at maximum capacity. There is obvious correlation between such periods of population growth and industrialization. Here Dr. Thompson is wary. Pieced together, his view seems to be that increased industrialization, that is, productivity, provides resources which result in a reduced death-rate. The consequent population increase itself creates a need for further industrialization so that the standard of living can not only be maintained, but also raised to meet a whetted appetite. This circular argument accounts for apparent discrepancies, since different parts of the book intersect it at different places. The main point is, however, clear—the Western countries have in effect passed their periods of population expansion; but the features which characterized the nineteenth century in the United States and in Great Britain will in the near future characterize eastern Europe and, particularly, Asia. "They are learning how to control their death rates and to use machines." Japan, India,

China and the Soviet Union will soon rival the West, which will "cease to have sole possession of the economic and political advantages of an efficient machine industry and a rapidly growing population". In the author's opinion this will lead to wars of rivalry unless the Western nations will relax their hold on raw material resources and on under-populated areas. The Netherlands East Indies, and British Borneo and New Guinea could, he says, absorb immigrants, so could Canada and South America. But he is harshest on Australia, declaring that so long as she wilfully keeps her population some sixteen millions below potential capacity, other nations should refuse to meet her resultant military need.

The second stage in population control comes when communities learn also to control their birth-rate. At first this control operates less effectively than control of the death-rate. A rapidly declining death-rate is coupled with a slowly declining birth-rate, so that the population grows. Then the birth-rate falls faster, while the death-rate probably becomes fairly stable, health measures having reached near-maximum efficiency. At this stage nations can be said to have *control* of population growth, but this does not imply, of course, that they have any population *policy*. However, nations with a conscious policy can put it into effect only when they have achieved control of birth- and death-rates. Control of the death-rate is not a flexible instrument. Control of the birth-rate could be, and it is here that policy must operate. Each nation must itself decide whether to aim at replacement, or at more or less than replacement. Its propaganda and its social values and inducements must be set accordingly. Until such a policy is decided and made known, each family will make its own private decision about the size of its family, possibly with disastrous effects on the general well-being.

The population policies of each nation should, says Dr. Thompson, "concern themselves with the adjustment of population to its resources, giving consideration to the manner of life it considers good". This definition is not valid, however, as long as population is uncontrolled in other parts of the world. The Malthusian situation arising there will almost certainly provoke wars. Dr. Thompson is explicit about this; if all mankind is to have a decent standard of living, and, as a consequence, to live at peace, the birth-rate should nowhere exceed one third of the physiological maximum. This dictum assumes a policy for peace, but militaristic nations, or those in dread of militaristic neighbours, will scarcely favour a reduced population. Population policy may then become the opposite of that calculated to promote the welfare of citizens considered primarily as human beings.

Apart from military considerations, Dr. Thompson sees no harm in a declining population for Great Britain, Italy or Germany, and advocates it strongly for China, India and Japan. But Australia, New Zealand and Brazil should expand, he thinks, and the United States stabilize at around the predicted 1975 level. The optimum birth-rate is different for different countries and at different times. The outstanding contribution of Dr. Thompson's book is this insistence that national population policies are practicable and essential, but that these cannot be settled in isolation. Relative population numbers should, if this thesis be accepted, become a subject for future international agreement.

# DE GENERATIONE

## Aristotle. Generation of Animals

With an English translation by Dr. A. L. Peck. (Loeb Classical Library.) Pp. lxxviii+608. (London: William Heinemann, Ltd.; Cambridge, Mass.: Harvard University Press, 1943.) 10*s*. net.

ARISTOTLE'S biological works have never lacked translators and commentators. The latter found in them ample scope for their learning, and particularly for their ingenuity, in so far as the texts, in the words of the late Prof. A. Platt, "have suffered terribly in the process of transmission to us, and are full of grievous blunders committed by scribes". The first complete English translations by Thomas Taylor, published in 1807–09–10, were printed in so small an edition that they are among the rarest of books. The translations available to the modern English student are: "History of Animals" (Cresswell, 1862) and D'Arcy Thompson (1910); "Parts of Animals" (Ogle, 1882, 1912 and Peck, 1937); "Generation of Animals" (Platt, 1910) and the present work by Peck (1943). The last-named author is at present working on another translation of the "History of Animals", which will complete the trilogy of Aristotle's biological works in the Loeb series. Dr. Lones' general survey of these works (1912) serves as an admirable introduction to their range and importance. That ancient and curious volume known as "Aristotle's Compleat Master-piece", first published in 1684, which was already in its thirty-second edition in 1782, is still in print, despite its fallacious title and useless contents.

Translations of Aristotle's biological works have as their main concern not questions of linguistics but of subject-matter, or in other words they appeal not so much to the Aristotelian scholar as to the biologist. Nevertheless, the perfect translation must be able to satisfy both the Grecian and the man of science. This would seem to require the collaboration of two workers, since it rarely happens that the diverse interests of language and science come to rest in one individual, as they do so happily in the majestic personality of Sir D'Arcy Thompson.

Dr. Peck's approach to his task is that of the classical scholar; but he realizes that Aristotle in this work on generation is an original thinker as well as a descriptive embryologist. Indeed, as Dr. Peck himself points out, Aristotle compiled the first systematic treatise on animal generation, in which he may be said to have: (1) founded comparative embryology; (2) favoured epigenesis as opposed to preformation; (3) initiated the study of organogenesis; (4) deduced the functions of the placenta.

In addition to the obvious advantage of printing the original Greek text and the translation on opposite pages, Dr. Peck gives us a carefully revised version of the former, and also a valuable exposition of Aristotle's thought, methods and technical terms. Further, there are a useful summary and a detailed index. Such defects as there are in this edition are of quite minor interest. For example (p. xix), it is not correct to say that "Harvey was indeed the first to make any substantial advance in embryology since Aristotle". Nor must we forget that Highmore, simultaneously with Harvey, demonstrated the real nature of the cicatricula of the fowl's egg. On page 205 Dr. Peck says that Aristotle's kestreus "cannot be the grey mullet, but is probably a species of *Muraena* or *Gymnotus*". The latter genus is confined to the

New World, and Linnæus's eastern species of '*Gymnotus*' could scarcely have been known to Aristotle. On the other hand, the mullet attribution is confirmed by Aristotle's statement that his kestreus had a gizzard-like stomach, which *Muraena* certainly has not. Page 302 *f*., Aristotle's placental fish was rediscovered by Steno in 1673 before J. Müller. Page 390, footnote *g*, includes a misprint which is good Scots, but not what Dr. Peck meant to say. But slips like these do not detract from the essential importance of the work, even if it is not ungracious to mention them, and all students of the history of biology will be deeply grateful to the author for an outstanding addition to Aristotelian literature. F. J. COLE.

# INORGANIC CHEMISTRY OF NITROGEN, PHOSPHORUS, OXYGEN AND SULPHUR

## Systematic Inorganic Chemistry of the Fifth- and Sixth-Group Nonmetallic Elements

By Prof. Don M. Yost and Horace Russell, Jr. (Prentice-Hall Chemistry Series.) Pp. xx+423. (New York: Prentice-Hall, Inc., 1944.) 6 dollars.

BY selecting a rather small but highly interesting and important part of the chemistry of the elements, the authors have been able to give, in a short compass, a very valuable survey of topics which should be of the highest value to students and teachers, and also, since adequate references to literature are given, to those seeking further information on the subjects with which it deals. Particular emphasis is laid on such modern aspects as molecular dimensions and shapes, and bond-lengths, and there are usually rather full statements of all the quantitative properties of the substances dealt with.

It is clear that the authors have made very full use of the original literature, and have provided concise yet highly informative summaries of a large number of papers. As an example, the fifteen-page account of the metaphosphates may be mentioned, this including all the results of a large amount of difficult literature in a clear, ample and readable form. The treatment is critical without being obtrusively so. There are many good graphs of properties and diagrams of molecular structures; but the book as a whole is rather weak on preparative chemistry, and the reviewer missed diagrams of apparatus even in cases, such as the description of the preparation of hydrogen persulphides, where these are essential in appreciating the methods.

Some matter which could well be omitted from such a book, such as the half-page dealing with the theory of electron gas on p. 141, would, in the reviewer's opinion, better have been replaced by preparative detail, but this is perhaps a point on which opinions will differ. In the description of the glow of phosphorus (p. 170) sufficient emphasis is not given to the work of Miller, quoted on p. 177; this section should be revised in a new edition. The reviewer noticed very few misprints; "Bayley" instead of Baly on p. 4, and $H_2PO_3$ instead of $H_3PO_3$ in the heading on p. 198, are examples of what can be put right in a later edition, and the text seems remarkably accurate. The book is very well written, the interest being maintained even in sections containing mostly numerical data, and students should find it stimulating and arousing interest in the subject. It is permeated by what one may call the 'research spirit', and the authors say in the preface that it contains much information from their own experience.

The fifth and sixth groups of the Periodic Table contain some of the most interesting elements, and this applies also to the metals, which the authors, unfortunately, have not been able to include in the book.

Whether for its well-conceived and executed plan, or for its objective tone, the book deserves very high praise indeed, and will undoubtedly take its place in the list of books every chemist will wish to possess. The printing, paper and binding are worthy of the text.

# THE RELATION OF BODY AND MIND

## Food for Thought

A Treatise on Memory, Dreams and Hallucinations. By Bernard J. Duffy. Pp. 160. (London, New York and Toronto: Longmans, Green and Co., Ltd.; Dublin: Abbey Publishers, 1944.) 10*s*. 6*d*. net.

THE evidence in favour of telepathic communication (supra-normal cognition or extra-sensory perception) is now enough, and more than enough, to convince any reasonable inquirer, and it may be time to consider theories to explain how it happens. A theory of physical transmission from agent to recipient, that is capable of experimental test by ordinary methods of scientific investigation, is to be preferred if it is at all possible, to any theory that cannot be tested in this way. Indeed, for those who hold that everything must have a physical explanation, such a theory is urgently needed.

Mr. Duffy puts forward a hypothesis of the relation of body and mind that belongs to the same genus as that of Descartes; namely, that mental processes are activities of a spiritual substance distinct from the bodily organism, but interacting with it through a specific physical mechanism. The mechanism Mr. Duffy suggests is that active brain cells produce weak radiation of wave-lengths about the range of the shortest used for radio transmission. Normally, each mind interacts with its own brain, but exceptionally with another; hence telepathy. The evidence quoted for the existence of such radiation is not convincing, but it seems a possibility, and it is almost certainly the last hope of a physical explanation of telepathy. There seems to be no reason why chemical reactions in nerve cells should not produce weak rays of wave-length between a metre and a micron; why radiation from a group of cells should not form a beam; why it should not be projected to great distances. On this hypothesis, telepathic reception should be highly localized; agent and recipient could be screened from one another; artificial production of rays of appropriate wave-length should have striking results. All these suppositions can be tested.

There are serious objections to any type of Cartesian theory of the body-mind relation, which even Mr. Duffy's ingenious suggestions do not overcome. There are considerable objections to any radiation theory of telepathic transmission. Still, an improbable theory which can be tested has a scientific value so long as it has not been disproved, and no theory in this sphere starts with any high probability. Mr. Duffy's theory, therefore, deserves serious consideration. A. D. RITCHIE.

# INTERNATIONAL ACTIVITIES IN SCIENCE*

By SIR HENRY DALE, O.M., G.B.E., P.R.S.

WITH the outcome of the War ever more certain, there can be no relaxation yet of the demand on what our scientific effort can contribute to the hastening of its end. It is none the less our duty to begin to look further ahead and to prepare for the part which science must play in the world which will follow. The needs of alliance in war have evoked, especially between the two great branches of the English-speaking nations, a closer interchange and collaboration in science, between men of different national traditions and loyalties, than has ever before been a matter of organized policy. It is not too early to begin to consider to what degree, and in what form, such a collaborative effort should be continued into the conditions of peace, and extended to scientific men of international goodwill throughout the world. Even in the twenty years of uneasy armistice which ended in 1939, a measure of co-operation among the world's scientific men was achieved.

Our traditions go back to days when the fellows of the Royal Society belonged to a community embracing all Europe in its enthusiasm for the new experimental philosophy, and the Society will have a particular duty to be among the leaders in the resumption of international activities in science, and to use all its influence to establish these on an ever wider and firmer basis. The Society has a standing committee on international relations in science, with its foreign secretary appropriately as chairman, to prepare for what action the Society can usefully undertake or promote, as the opportunity presents itself. Meanwhile, we may observe other signs that the spirit of international friendship and recognition in science is beginning to move again, even while the chaos of war is still with us. Among such signs, we may note that one of the committees which, since their foundation in Stockholm, have awarded the Nobel Prizes with unchallenged impartiality among the scientific discoverers of all nations, has resumed awards this year. The Royal Society has welcomed the return to London of a group of distinguished French leaders in science from the United States of America, whither they had escaped from the hostile occupation of their country. We have been able to share their rejoicing at the liberation of France, and to welcome here others who had remained there, often in hiding and always in peril, as leaders in the steadfast resistance opposed by all but a negligible minority of the French men of science to the enemy's demands for their collaboration. Even to-day we are able to welcome another distinguished French colleague, just arrived from Paris —Prof. Emil Borel. We are glad to think that new and lasting bonds of comradeship in science have been created for us with those from other allied countries occupied by the enemy who have been our country's war-time guests, and through them with all the men of science in the countries which they represent. A happy chance brings also to our meeting to-day four men of science from the U.S.S.R. Very near to the heart of every British man of science is the desire for a growing intimacy of confidence and collaboration with our colleagues of that great partner-nation in the war for the world's freedom.

The Royal Society had recently the opportunity of showing its interest in the revival of international scientific co-operation in another special connexion. During October 16–19, a small international conference met in the Society's rooms, under the auspices of the Health Organisation of the League of Nations, to discuss the creation of an international standard of reference for penicillin and the definition, in terms of this, of a unit of activity.

Though the League has failed tragically of its central purpose, it has achievements of value to its credit, and science has an interest in ensuring the permanence of some of these. I have myself had the privilege of taking part in the activities of an international commission under the Health Organisation of the League, which succeeded, in the years between the Wars, in obtaining world-wide acceptance of standards and units of activity for a whole range of modern remedies—antitoxins, hormones, vitamins and certain drugs—the strength of which could only be determined by direct biological measurements of the specific activity, in comparison with that of a fixed standard preparation in each case. Insulin was an early instance of a new remedy requiring such intervention; its general use for the treatment of diabetes could not have attained the present level of safety and effectiveness, unless a world-wide uniformity on these lines had replaced the chaos of widely different units in different countries, which was threatened in 1923. Now research has produced another new remedy, penicillin, the success of which, in the treatment of a range of dangerous infections, has also had such a dramatic quality that its reputation has spread rapidly beyond our scientific community and caught the interest even of a war-distracted world. Here, indeed, was a discovery which could rank as a major contribution of science to the mitigation of the suffering which war inflicts, and, at the same time and no less, as a gift of healing to mankind at peace. The needs of war had given a stimulus to the researches which proved penicillin's remedial value, but its rapid production on an adequate scale had to face greater difficulties in Great Britain, where material and human resources had been more completely absorbed by earlier requisitions than in the United States. So the present position was reached, in which, as we are proud to recognize, the existence of penicillin and then, after a decade, the methods by which it could be separated in sufficient purity to demonstrate its brilliant possibilities as a remedy, were discoveries made here in England, while, in the further researches and technical developments needed for its large-scale production, our American colleagues have played a major part.

Thus early in its history, therefore, penicillin and its applications had become a matter of international concern; and, though war had restricted the work in this field almost entirely to scientific workers of the English-speaking peoples, and had brought them into an unusual intimacy of co-operation, progress had been so rapid and action so urgent that there was a real danger of a divergence of meaning in the terms used to express its activity and define its dosage, even among the few countries already using it. Prompt action was required to avert this by accepting a common standard of reference; and, when the proposal of a conference for this purpose was made from Great Britain to the League of Nations Health Organisation, we were grateful to our colleagues from the United

* From the address at the anniversary meeting on November 30.

States, as well as from Canada and Australia, for the generous promptitude with which they agreed to make the journey to England, so as to meet with us here in London. After all arrangements for the holding of the conference here had been completed, the liberation of Paris opened a new possibility; Dr. Tréfouel, now director of the Pasteur Institute in Paris, was able at the last moment to accept an invitation to join us, and thus to give our deliberations, and our eventual agreement, a wider international basis.

To illustrate how rapidly a divergence may arise under present conditions, I may just mention the fact that several different penicillins have now been recognized, produced by variations in the metabolism of the growth, possibly due to mutations of the mould itself, possibly to changes in the nutritive conditions offered to it by the medium or the cultural method employed. Three such varieties of penicillin have already been isolated in pure condition, and distinguished by certain chemical characters; but, while British workers had come to refer to these as penicillin 1, 2 and 3, their colleagues in America spoke of penicillin F, G, and X; and it was not until they met around the table at the Royal Society a few weeks ago, but then in less than ten minutes, that they became quite certain of the identity of 1 with F, of 2 with G, and of 3 with X. All these penicillins have the specific remedial action in high, though not quite identical degrees, and there are probably differences, still to be explored, in their proportional efficiencies against different infective organisms. When once their identities were thus put beyond doubt, however, the small conference had no hesitation in deciding, for the present, to use as the common basis of reference a sample of the penicillin which is predominant in most preparations now available, and most easily obtained as a pure salt in adequate quantities. The unit could then be defined as the activity of a precise, though very small weight—0·6 $\mu$gm.—of a particular sample of the perfectly dried, crystalline sodium salt of penicillin 2, or G; and the unit thus chosen for definite fixation, and for international recognition henceforward, was, by a unanimous choice, so defined as to be as closely equivalent as possible to the unit first propounded by Sir Howard Florey's team of collaborators, and widely known as the 'Oxford' unit.

The international standard for penicillin is thus added to an already numerous series, of which the custody, on behalf of the League of Nations Health Organisation, has been shared by the National Institute for Medical Research with the State Serum Institute of Denmark, at Copenhagen; and all these standards, we may hope, will be available for transfer to whatever international authority may be established in succession to the League, as a tangible and material result of genuinely international collaboration, which the League has been able to initiate and maintain among men of science, to the permanent advantage of the world.

Though penicillin has rightly made a special appeal to the imagination and sympathetic interest of a wide public, it is, of course, only one out of a varied range of inventions and discoveries, hastened by the stimulus of war's demands and produced, in many cases, behind the veil of its secrecy; but ready, when peace returns, to take their proper place as new gifts to the welfare and the civilized progress of mankind. From what has already been made generally known, it is clear that we may look forward to revolutionary advances in the means of communication and in the speed and safety of travel across the world and in methods of controlling insect pests and the diseases which insects convey. These are but a few examples of the gains which we and the world may hope to set against the tragic loss and sacrifice of the years of war.

There were probably few who even suspected in 1939 that science, in countries then so dangerously unready, would find itself, before the War ended, in its present position of central importance. None of us, I think, would claim more for science even now, than to have played in this War a part of growing predominance in the provision for the fighting men of the material means of warfare, without which their heroism and sacrifice could not have prevailed. Even that duty, loyally accepted, is one from which the scientific community of the free nations must long for the release which victory will bring. But, while the operations of war have come to depend on science to a degree beyond all earlier experience, it cannot be doubted that little more than a beginning has yet been made in exploiting the possibilities of destruction, which science could progressively offer, if the world should continue thus to misuse it, and if science were still on offer for such ends. Allow me to quote a passage from a letter which the Prime Minister, whom we are proud to number among the fellows of the Royal Society, wrote a year ago to Prof. A. V. Hill, in sending his greetings to Indian men of science.

"It is the great tragedy of our time," wrote Mr. Churchill, "that the fruits of science should by a monstrous perversion have been turned on so vast a scale to evil ends. But that is no fault of science. Science has given to this generation the means of unlimited disaster or of unlimited progress. When this War is won we shall have averted disaster. There will remain the greater task of directing knowledge lastingly towards the purposes of peace and human good." Noble words indeed, and a profession of faith which will find an immediate echo in the hope and the desire of every true man of science. "When this War is won we shall have averted disaster"—surely that is a confidence which every one of us will long to share. It must be clear, however, that Mr. Churchill's reference was to the present threat of disaster, from which the prospect of our escape is even more fully assured to-day than when he wrote, a year ago. We may be certain that nobody sees more clearly than he that the threat of final disaster to all man's hopes and achievements will not be for ever averted, if the possibility of the "monstrous perversion" of science is allowed to remain and to continue its evil growth. Even in the past year our enemies have thrown a new and vivid light on future possibilities, by the new weapons which science has enabled them to put on trial for our destruction. Though a people's unflinching courage and an answering effort of science and organization, together with the progress of the Allied Armies over the launching areas, have given us confidence that flying bombs and the like will not affect the issue of this War, the warning which they give, as to what the future might hold, is not the less clear. The writing on the wall must be plain for all to read. If, when the memories of the present War begin to fade, the world should allow science again to be exploited by a nation grasping at predominance by conquest, science will no longer be invoked only as an aid to what valour can achieve by land, sea or air, but as an agent, in itself, of blind annihilation at an ever-lengthening range.

When we men of science regain that freedom for the ultimate preservation of which we have loyally accepted, through these tragic years, the bonds of secrecy and submission to authority, we cannot put aside with these our proper share in the new responsibility for the future of mankind, which the experiences of this War have laid upon the men of goodwill in all nations. It is true, indeed, that neither the present abuse of science, nor any possibility of final disaster to civilization which might come of a future perversion of its powers, can be charged as a fault to science itself; no more, indeed, than we could properly charge to religion, as such, the wars which once devastated much of Europe in its name. But we men of science cannot escape from our growing share in the responsibility, in "the greater task", as Mr. Churchill has written, "of directing knowledge lastingly towards the purposes of peace and human good". No man of science has the right to prescribe for another his interpretation in detail of that duty; but there is one aim which may unite us, perhaps for the most effective action within our common grasp, and one which is worthy of all our common influence and effort. Let me quote again from Mr. Churchill's letter: "in this task", he writes, "the scientists of the world, united by the bond of a single purpose which overrides all bounds of race and language, can play a leading and inspiring part".

# ROYAL SOCIETY MEDAL AWARDS, 1944*

## Copley Medal

THE Copley Medal is awarded to Sir Geoffrey Ingram Taylor, Yarrow research professor of the Royal Society, in recognition of his contributions to knowledge of aerodynamics, of hydrodynamics and of the structure of metals, which have had a profound influence on the advance of physical science and of its practical applications.

Taylor is probably the most accomplished living exponent of the application of the methods of classical dynamics to problems of fluid motion. To great mathematical powers he adds high skill as an experimenter. His theoretical work is particularly noteworthy for its approach to reality. In place of the ideal conceptions presented by perfect incompressible fluids moving in stream-line motions and perfectly elastic solids, with which his great forerunners at Cambridge dealt, Taylor has studied turbulent motion, viscous and compressible fluids, and plastic movements of metals, obtaining results of great importance for the understanding of a wide range of phenomena.

Taylor's early work was concerned with eddy motion in the atmosphere, and opened up new fields of meteorological investigation. It threw light on the variation of wind with height and on the transference of heat and water vapour in the atmosphere, with a consequent bearing on the formation of fog. He also carried out work on the tides. Later he developed the theory of general turbulence, to which statistical methods can be applied which are somewhat reminiscent of the kinetic theory of gases.

Among Taylor's extensive researches on precise hydrodynamical problems, that on the motion of a viscous fluid between two coaxial cylinders, rotating with any speed in the same or in opposite directions, may be particularly mentioned, since it offers the only case so far of the complete solution of a problem of motional instability in the viscous liquid. In dealing with the elastic deformation of metals, Taylor has shown how the slip planes can be determined in certain cases by purely geometrical methods, and has offered a formal theory of the process of work-hardening in single crystals.

Taylor has also applied his great mathematical powers to a variety of practical questions. During the War of 1914–18 he did work of great distinction on aerodynamical problems for the Advisory Committee on Aeronautics, and during the present War he has been extensively concerned with complicated problems concerning the propagation of explosive processes. Taylor's work may be said to be in the line of a great British tradition, which, in the past generation, was represented by investigators like W. J. M. Rankine, Osborne Reynolds and Rayleigh. Like these he has the mathematical equipment, the originality and the insight required for the fundamental solution of problems presented by practical experience in the laboratory, in the workshop, and in the wider world. Taylor has carried his quest for experience and for scientific problems on to the sea and into the air. His work during this War has been of the greatest value to the nation and its allies, and his fundamental discoveries are extending the boundaries of knowledge for all mankind.

## Rumford Medal

The Rumford Medal is awarded to Dr. Harry Ralph Ricardo, consulting engineer, in recognition of his important researches on the internal combustion engine.

There is a special fitness at the present time in the award of this Medal to one who, during the last twenty years, has been the leading spirit in the development of the high-speed internal combustion engine. Ricardo's researches were begun under Bertram Hopkinson in 1905 and continued, after he left Cambridge, as a consulting engineer in his grandfather's firm. Investigating the effect of turbulence on the speed of combustion, he was led to appreciate the importance of 'knocking', to determine its cause and to show that the tendency to 'knock' is dependent on the nature of the fuel. Taking charge of a special design department for his firm, he produced a four-cycle, supercharged aero-engine, long in advance of accepted practice. In 1916 he was invited to plan a special engine for the secret fighting machine which was to become known as the tank, and his unorthodox and daring design was an outstanding success.

Forming a private company to maintain a laboratory for research on the internal combustion engine, Ricardo further investigated the relation of the phenomenon of 'knocking' to the maximum compression-ratio of the engine and to the character of the fuel, matching the latter by adding toluene in variable proportion to heptane, and thus paving the way for the modern octane-rating.

It is not possible here to make more than general reference to the far-reaching influence of Ricardo's investigations and his steady advocacy on the design of slide-valve engines, of sleeve-valve aero-engines, of high-speed Diesel engines, and on other important developments in engine design. In all directions there is evidence of his special genius and flair for design,

*Remarks made by Sir Henry Dale in presenting the Royal Society Medals for 1944.

and, behind this, of his full appreciation of the thermodynamical principles which control the behaviour of engines, and of a deep knowledge of the physical and chemical factors involved, as well as of the characters of fuels and of the materials of the working parts.

## Royal Medals

A Royal Medal is awarded to Prof. David Brunt, professor of meteorology in the Imperial College of Science and Technology, in recognition of his contributions to meteorology.

Brunt has made fundamental contributions to this science in its statistical, dynamical and physical aspects. The subjects which he has treated include cycles in weather; atmospheric radiation; atmospheric turbulence; the dynamical causes of rainfall; instability and convection in their bearing on the forms of clouds and on soaring flight; and the dynamics of depressions and anticyclones. He has rendered an outstanding service to his subject by his book on "Physical and Dynamical Meteorology", in which he gives the first connected and critical account of the physics and dynamics of the atmosphere, and reduces to order a large amount of material which was previously available only in isolated papers. The book contains much original matter, and has played a leading part in the recent development of meteorology in all countries.

Brunt has been a pioneer in the analytical approach to his subject. Of recent years he has devoted several papers to the discussion of the factors which influence bodily comfort, and has gone far to provide a natural basis for the classification of climates in relation to human health and human needs.

For many years Brunt has conducted, at the Imperial College of Science and Technology, a flourishing school of meteorology, which has attracted students from all parts of the world. He has always been generous with his services to colleagues in other fields who have required expert meteorological assistance. During the War his wide knowledge and sound judgment on meteorological questions have been of the utmost value to the cause of the nation and its allies.

A Royal Medal is awarded to Dr. Charles Robert Harington, director of the National Institute for Medical Research, in recognition of his work on the structure and synthesis of thyroxine, and on the chemical basis of immune reactions.

Harington's reputation, as a leader among biochemical investigators, was established by a brilliant series of researches dealing with the chemical nature, the origin, and the form of the natural combination of the thyroid hormone, thyroxine, with its remarkable content of iodine. He improved the method of isolating this active principle from the thyroid gland, determined its structural constitution and then produced it by artificial synthesis. Later he demonstrated that diiodotyrosine is present in the gland and accounts for the balance of its iodine content. By enzymatic cleavage he proceeded to show that thyroxine and diiodotyrosine are natural amino-acid constituents of the complex thyreoglobulin. These discoveries gave an entirely new precision to knowledge of the thyroid hormone, of the manner of its natural occurrence and function, and of the diseases which result from excess or defect of its supply from the gland.

In more recent years, Harington's work has contributed very important advances to knowledge of the chemical basis of immunological specificity. By a new method of coupling haptene groups artificially to proteins, he has studied the role of carbohydrates and of tyrosine in developing antigenic properties. By such methods he has created artificial antigens, the specificity of which is determined by the attachment of physiological active haptenes, such as thyroxine and acetylsalicylic acid. He has thus produced and determined the limits of specificity of antisera reacting with free thyroxine or acetylsalicylic acid, and has observed the antagonism of such sera to the physiological effects of such principles in the animal body. In other directions also Harington has made brilliant contributions to biochemical knowledge, as by his work on the conditions determining the crystallization of insulin and on the synthesis of glutathione.

## Davy Medal

The Davy Medal is awarded to Sir Robert Robertson, lately Government Chemist, in recognition of his researches on explosives, analytical methods, the internal structure of the diamond and infra-red absorption spectra.

After studying at St. Andrews, Robertson made his first acquaintance with the field of explosives as a chemist at the Waltham Abbey explosives factory, where he was occupied on the nitroglycerine plant. He acquired a knowledge of all aspects of the manufacture of cordite, and contributed improvements, such as the acetone recovery process which has been widely adopted. His researches in this period covered calorimetric measurements, and in particular the study of the mode of decomposition of gun cotton which led to the publication of work of great practical importance on the stabilization of that material (1916).

A succession of spontaneous explosions in cordite magazines led to a visit by Robertson to India and to the issue of an exhaustive and valuable report in February 1917. Shortly afterwards he entered the Research Department at Woolwich as superintending chemist, and he occupied this post with distinction until 1920. Much valuable work was done before and during the War of 1914–18. A process for the manufacture of T.N.T. introduced novel features and prepared the way for the large T.N.T. factories established under Lord Moulton. Other notable achievements by Robertson were the introduction of cordite R.D.B., which relieved the acetone position, and of amatol, of which it was said by the Director of Artillery that "amatol won the War". Throughout his time at the Woolwich Research Department, Robertson showed himself a resourceful investigator, an able leader and an indefatigable worker.

There followed for Robertson a further period of effective organization and active enterprise in research, as Government Chemist. He was one of the first to recognize the importance of infra-red spectrography for the determination of molecular structure, and in his pioneering work on the infra-red spectra of ammonia and of arsine he pushed the accuracy of the instruments then available to their ultimate limits. These researches directed the attention of chemists to the possibilities of the analysis of molecular vibrational and rotational bands, and materially assisted in opening up the wide field which has been explored in recent years. Robertson's studies of the absorption spectra of diamonds have produced

results of very great interest; they show that diamonds exist in two types differentiated by the condition of strain originating in their high-temperature formation.

During the present War Robertson has occupied very responsible positions in relation to the earlier field of his researches and has played a keen and active part in the contribution of chemistry to the national emergency.

### Darwin Medal

The Darwin Medal is awarded to Prof. John Stanley Gardiner, lately professor of zoology and comparative anatomy in the University of Cambridge, in recognition of his life's work on coral reefs.

Gardiner is universally recognized as an authority on coral reefs and on the organisms associated with such habitats. His contributions to these fields of biological and geographical research began not long after his graduation, when he was a member of the coral reef boring expedition to the atoll of Funafuti, organized by the Royal Society in 1896. Since then he has himself organized and led two most important expeditions, the first to the Maldive and Laccadive Archipelagoes in 1899 and the second to the Indian Ocean in 1905; the results of these expeditions are embodied in nine large quarto volumes and represent a most valuable contribution to a field of knowledge closely associated with the work of Charles Darwin. Within recent years Gardiner has organized and, to a large extent, directed the Cambridge Expedition to the Suez Canal, 1924; the Great Barrier Reef Expedition, 1928–31; the John Murray Expedition to the Indian Ocean, 1933–34; and the expedition to Lake Titicaca in Chile, 1937. He is an authority on the taxonomy and systematics of Alcyonarian and Zoantharian Corals, and has taken a keen interest in their ecology and geographical distribution.

Gardiner realized the great importance, in the study of corals, of the examination of the polyps themselves, as well as of their coralla, and he paid special attention to variations which may result from slight differences of habitat and are correlated with physical and other conditions, showing that in several instances so-called 'species' are merely variations. He also realized the immense value of an accurate knowledge of the coral fauna of any given locality in relation to its environment, in enabling one to deduce the conditions under which tertiary and earlier coralline deposits have been formed.

There is scarcely a branch of research on corals and coral reefs in which Gardiner's work is not of great importance. It was his observations on the Funafuti atoll and the atolls of the Maldive and Laccadive Archipelagoes that caused him to realize that no one theory, such as the 'subsidence' theory of Darwin, or the 'solution' theory of Murray, can account for the formation of all such reefs and atolls though, when once formed, every reef has been moulded and modified by world-wide phenomena, such as a change in the relative levels of sea and land.

Stanley Gardiner has given us an admirable summary of this, his life's work, and of the conclusions that he has drawn from it, in his book "Coral Reefs and Atolls", a most valuable supplement to Darwin's own volume "On the Structure and Distribution of Coral Reefs". There is a special fitness in the award of the Darwin Medal for work of such "acknowledged distinction in the field in which Charles Darwin himself laboured".

### Hughes Medal

The Hughes Medal is awarded to Prof. George Ingle Finch, professor of applied physical chemistry in the Imperial College of Science and Technology, in recognition of his fundamental contributions to the study of the structure and properties of surfaces; and for his important work on the electrical ignition of gases.

Finch has carried out two important bodies of research in different fields, both involving electrical considerations in a fundamental manner. The first was a detailed study of the electrical ignition of gases, the second the application of electron diffraction to a wide range of chemical and physical surface problems.

In his work on electrical ignition, Finch not only elucidated the chemistry of the ignition of simple gaseous systems, but also was the first to develop the theory of the sparking ignition coil. His inductance component control interrupter has been used by the Radio Research Board for the production of single electromagnetic pulses. In the course of his ignition work, Finch developed, as a pioneer in Great Britain, the high-speed cathode-ray oscillograph.

In the field of electron diffraction Finch has developed the electron diffraction camera into an equipment giving results of high accuracy with speed and ease of manipulation. The Finch camera has found wide application outside his laboratory, and examples made under his direction have been installed, among other places, at the National Physical Laboratory, University College, London, the University of Brussels (two), and in the laboratories of Messrs. Ferranti and of other industrial research centres. The pictures which he has obtained with it are outstanding in beauty of detail. He has contributed notably to the interpretation of the electron diffraction pattern and has applied his methods to many problems of theoretical and practical importance.

Of special interest are Finch's studies of the relation between crystal size and lattice dimensions and, in the more practical field, his investigations into the effect of the substrate on adhesion of electro deposits, into the nature of polish and into the mechanism of boundary lubrication and the wear of sliding surfaces. In all these he has materially advanced our knowledge, and his work on sliding surfaces, in particular, has found important applications in engineering practice.

His work during the War has covered a variety of fields, some involving the application of electron diffraction. That which he has carried out as scientific adviser to the Ministry of Home Security, while less closely related to his normal lines of research, has been of the greatest value.

## ANIMAL PRODUCTION AND ANIMAL BEHAVIOUR

On Tuesday, October 24, the British Society of Animal Production held a discussion on the British sheep industry; on the morning of October 25, a joint meeting with the Institute for the Study of Animal Behaviour was held to consider the grazing behaviour of sheep and cattle; the Institute, on the afternoon of October 25, discussed the food preferences of dairy cows and the importance of the study of behaviour from the veterinary aspect.

The familiar classification of British sheep into hill,

lowland and Down types tends to split the industry into distinct sections, although it implies separation on ecological grounds or according to conditions of husbandry. In fact, as Prof. R. G. White clearly demonstrated in his opening general survey, the sections of the sheep industry in Great Britain are closely interrelated and interdependent, so that the industry must be considered as a whole, with that whole in turn forming an appreciable factor in the complex pattern of British agriculture. Although war-time food production policy has tended to relegate the sheep to a lowly place in the British livestock industry and to distract popular attention from its important role in British agriculture, we, as a nation, like mutton and lamb. Sheep consume home-produced grass, fodder crops and foods not suitable for human consumption, and are thus quite different from pigs and poultry. We have large areas of hill and mountain lands which under present conditions can only be exploited economically by sheep-grazing. The sheep of these areas are important not only in themselves but also because they are the basis on which the great majority of the 'flying flocks' of the lowland pastures are founded, and these in turn depend largely upon the arable flocks for the supply of rams for mating to the hill ewes and their crosses to produce fat lamb. If, after the War, we have to increase our home meat production, this will be done mainly by the sheep, and the sheep industry as a whole will be involved.

Mr. D. H. Dinsdale showed, from the economic point of view, that although there is a complementary relationship between hill and lowland sections of sheep farming, and recent trends have emphasized the importance of the foundation nature of the hill flocks, there is also a competitive relationship, as both tend to cater for the same market for meat. To this end the changes in the industry have been of character rather than extent. Most hill farms are small economic units and receive only a small proportion of their income from sheep and wool; the problems of a broad policy for improvement and rehabilitation would, therefore, affect many people. There are physical limits (soil, climate) to improvement as well as economic limits (price, capital expenditure); also, in the sheep enterprise on hill farms, questions of fluctuations in the annual lamb crop, of replacement of stocks (most hill flocks being self-maintained), and of selection for characters of hardiness and mothering ability, raise important biological considerations on which more data are needed. He concluded that no "single-track solution can be expected, of itself, to restore hill sheep to the place they should hold in a balanced farm economy".

In the ensuing discussion, the prime necessity was emphasized of a co-ordinated programme in Britain for improvement of stock and of land, for social betterment and co-ordination between forestry and agriculture in land use; knowledge is required of the efficiency of both sheep and grazing, of suitable ratios of cattle and sheep for successful grazing management, and of losses of efficiency due to inappropriate selection, to subclinical parasitism, and to low nutritional levels of pregnant ewes during winter.

The general lack of adequate data for framing policies was neatly exposed by Mr. T. L. Bywater, who presented a summary of the results of the University of Leeds crossbreeding trials. These have been carried out since 1898, first at Garforth and later at Askham Bryan, and bear upon the question of the most suitable kinds of stock for the flying flocks on long leys. Many different breeds and crosses of ewes were used, mated to different breeds of rams; records of fertility and of weight and age of lamb when sold have enabled a general comparison of the results of the various crosses to be made on a basis of the total live weight of lambs produced per ewe put to the ram. A significant feature is that smaller differences in results occur from different breeds of rams as compared with different types of ewes—in flying flocks the ewe is more important than the ram; moreover, the results from individual rams of the same breed vary more than between rams of different breeds. For desirability in a flying flock, the ewe should be thrifty, able to rear on the average about $1\frac{1}{2}$ lambs per year, have a sufficient milk yield to produce not less than 120 lb. live weight of lambs at six months or less, and be capable of bearing at least five lamb crops in her life-time. Under the conditions represented in these trials, such characters were found to be most fully expressed in 'North' (Border Leicester × Cheviot) and Masham (Wensleydale × Swaledale) ewes, while for general conditions such types as the Clun, Kerry Hill, Greyface (Border Leicester × Blackface), and Welsh crosses could be relied upon. For mating to such ewes the ram should be able to grow quickly and to fatten readily and be well developed in loin and leg; Suffolk, Oxford and Hampshire rams had been satisfactory, with Suffolks giving the most consistent results.

Mr. Bywater contended, and other speakers supported him, that it is necessary to have similar trials carried out in other localities before an enlightened policy can properly be devised. Among the allied problems to be taken into account are the quality of the lamb product, the most suitable methods of measuring productivity, profitability and depreciation, as well as the source of supply of ewes. In any event, the possibility of different combinations of ewes and rams gives advantages in adjusting production to the various local circumstances; fresh combinations of breeds may be well worthy of study.

The complexities of management of arable flocks were discussed by Mr. J. F. H. Thomas. This section of the industry has declined for economic reasons—lower grain prices, expansion of dairy cow production, high costs of labour and of cultivations. But in spite of these, arable flocks in the south of England enable the large areas of unfenced, unwatered land on the chalk formations to be utilized and the fertility of the ploughland to be maintained. So far as the sheep themselves are concerned, the important questions are those of the suitable types or breeds for commercial production, the standard of which is affected by the present low fertility. Over-specialization on high carcase quality has neglected the factors of high fertility and milking ability of the ewe. Mr. Thomas does not believe, although some of the subsequent speakers did, that the only future for a able flocks is to produce rams for crossing purposes. He sees a favourable prospect for the commercial meat-producing flock, provided that all conceivable sources of loss can be reduced, whether they are due to defects of management, to parasitism (to which the intensive system predisposes but which can be controlled largely by good husbandry), or to other diseases that are favoured by heavily stocked land. He considers that this most complicated branch of the livestock industry has as yet received little help at the practical level from the agricultural scientific worker—and the general trend of the subsequent discussion admitted this by implication, although the

advantages of phenothiazine in control of parasitic worm infestation were stressed.

The second day's proceedings indicated some of the ways in which scientific inquiry is throwing light upon practical problems, and in some cases leading to a reconsideration of attitude towards them.

Mr. John Hammond, jun., summarized the results of observations on the breeding season in sheep and its extension by treatment with pituitary extracts and pregnant mare serum, which induce ovulation in anœstrous ewes, but without heat at the first ovulation. This year it was found that stilbœstrol administration, following injection of mare serum hormone, failed to accelerate onset of heat, and that treatment with pregnant mare serum alone, followed by artificial insemination, did not lead to fertilization. The maximum lamb crop under practical conditions would be produced, without treatment, by mating in mid-October and again in February or March, when a second crop could be expected from about 25 per cent of the ewes; with successful hormone treatment, a natural mating in October could be followed by a second service in June.

Experiments at Cambridge on the feeding of pregnant ewes were described by Mr. L. R. Wallace, who showed that lambs from ewes allowed to lose weight during the last six weeks of pregnancy were significantly lighter at birth than those from well-fed ewes. Further, the milk yield of the former ewes was, both at the peak and throughout a sixteen-week suckling period, materially less than that of the second group. This greatly affected the growth of the lambs, which at sixteen weeks averaged 56 lb. and 72 lb. for the two groups respectively. The importance of the level of nutrition during late pregnancy was emphasized by the spectacular differences in size at birth of the lambs from groups of ewes which had been well fed either throughout or during the last two months of pregnancy, as compared with those which had been poorly fed throughout or for the last two months. The ewe's udder remains small, and little affected by feeding level, until ninety-one days of pregnancy; after this the degree of its development is markedly influenced by the nutritional level of the ewe.

Detailed observations on an inbred Romney flock enabled Dr. Nancy Palmer to present a general picture of wool-growth on a unit area of skin; the length of fibres is determined by follicle density at birth, the subsequent rate of skin expansion, and the weight of wool produced. The last factor is found to be the same every summer for all sheep, of any age, in this particular flock.

The practical importance of Mr. Wallace's findings is patent; those of Dr. Palmer were shown by several speakers to throw light upon some of the factors which have to be taken into account in selecting for density of fleece-covering on one hand and increased body-size on the other.

The succeeding papers were concerned with an aspect of livestock management which has received relatively little direct attention. Though conditions of animal behaviour have long been tacitly recognized as affecting experimentation and practical procedures, apparently only in recent years have they been subjected to scientific study, interpretation, and even deliberate exploitation. For example, Dr. J. E. Nichols referred to one of a series of investigations on the problem of drought-feeding in Western Australia, in which the preferential grazing of the sheep and their habits of necessary and unnecessary movement were studied parallel with observations on the food values and ecology of different forms of *Acacia aneura*. As a result, it proved possible to devise, in the particular circumstances, a practical, and economical, procedure for maintaining the condition of the stock and preventing losses by exploiting the highly developed discriminatory sense of the sheep for the most nutritious shrubs and conserving their expenditure of energy by restricting their travelling as much as possible.

This evoked instances of how similar behaviour patterns could be examined in relation to preferential grazing in Britain, and consequently to the selection of more highly utilizable fodder plants and grasses, and to increasing the efficiency of food utilization under hill conditions as well as in folded flocks.

Mr. A. N. Worden communicated a résumé of Prof. Johnstone-Wallace's studies at Cornell on the grazing habits of beef cattle. From observations on the time taken in grazing and travelling, on the mechanics, methods, and selectivity of grazing, and on the frequency of defœcation, principles of rotational use and management of the pastures can be formulated. While the idea and practice of rotational grazing are not new, it has become clear that detailed investigations on these lines are necessary to enable the most efficient utilization of the various patterns of pasture-growth to be made, if only to overcome the loss of efficiency due to the rapid reduction of herbage consumed as the amount available for consumption is reduced by grazing. Our present ideas of what constitutes good pasture and good management of stock and pasture may require modification.

A similar view in relation to byre feeding emerges from Mr. K. L. Blaxter's observations on the habits and food preferences of dairy cows; refusals of food may occur before the mechanical satiation of the digestive tract, which places an upper limit on appetite, is reached. Broadly, food preferences are in the order: young grass, excellent quality hay, certain protein cakes and cubes, green fodders and roots, certain cereal and protein meals, average hay, then cereal chaff and straw. Moreover, the rates at which different foods are eaten, and at which different cows eat, vary greatly, the differences being most noticeable with bulky foods. Since the most nutritious foods are taken first and eaten most rapidly, these considerations must certainly affect herd rationing, where individual feeding is impossible through lack of adequate housing and facilities.

Some of the variables in this field are easily recognizable, others are as yet less obvious; examples of both kinds were suggested in the discussions which followed these papers. Thus a fertile ground was prepared for Dr. J. T. Edwards' analysis of the development of the study of animal behaviour and its general importance from the aspects of natural history and psychology, as well as in its didactic and economic considerations. In respect of the last, he instanced the work at Cornell, that of Stapledon (see *Vet. Rec.*, June 3, 1944), and Walton's observations on artificial insemination. Other speakers gave further examples of the necessary extension of the general approach, especially with regard to questions of degree and spread of parasitism in relation to grazing and other habits; these served to strengthen Dr. Edwards' plea for provision for systematic research on animal behaviour at institutes dealing with problems of animal husbandry and agronomy, and for the incorporation of appropriate courses at least into the veterinary curriculum. J. E. NICHOLS.

# OBITUARIES

## The Right Hon. Lord Moyne, P.C.

IN the preface to "Atlantic Circle", Lord Moyne says that had it not been for the South African War (for which he volunteered instead of going to the university) he would have become a biologist. A man endowed with his gifts of character and intellect, reinforced by a tireless energy and ample means, could scarcely have failed to make his mark. As it was, science had to take second place as an intermittent hobby pursued in the intervals of an exceptionally strenuous public life; and it was not until the last few years before the War that Lord Moyne was able to indulge more fully his taste for the biological sciences, among which anthropology took a prominent place.

Lord Moyne made a number of voyages in his steam yacht *Rosaura*, of which the last two, in 1935–36 and 1938, were scientifically the most important. These were no pleasure cruises. They had as their main objects the collection of ethnographical, archæological and zoological records and specimens for the British Museum and the London Zoo, and these objects were pursued with Lord Moyne's characteristic zeal, efficiency and courage. Danger seemed to attract rather than to repel him. At any rate, he was never afraid to take risks which seemed justified by the end in view, and it was only by great skill and (it must be admitted) a fair spice of luck that disaster was averted on each of these expeditions, which involved the wrecking of his two launches in New Guinea and damage to his yacht in the pack-ice off Greenland.

These two expeditions yielded a rich harvest, which included a splendid series of photographs taken by Lady Broughton, and colour films of great beauty and scientific interest. Out of the large ethnographical collection from New Guinea and the East Indies made in 1936, the British Museum received as a gift more than three hundred selected specimens, as well as photographs, all of a kind new to science or not hitherto represented in the national collection. The majority were from the almost unexplored southern regions of Netherlands New Guinea and from the little known Sepik and Ramu Rivers of the Mandated Territory. They included many objects of large size such as carved house posts, paddle spears and 18-ft. long blowguns, the safe transport of which would have been beyond the power of the ordinary collector without a yacht. From the 1938 expedition the British Museum received a very large and interesting collection of antiquities, chiefly pottery, excavated in the Bay Islands, Honduras. Other leading ethnographical museums including those of Oxford and Cambridge, and the Royal College of Surgeons, received a share of the spoils. Before the dispersal of his collections, Lord Moyne arranged attractive exhibitions of them at his house in Grosvenor Square (see *Man*, No. 121; 1936; and No. 71; 1938).

Lord Moyne was the first to publish records of a group of 'pygmy' folk from the Aiome Mountains on the Upper Ramu River, the average stature of which (based on a small number of individuals) was the lowest ever reported from New Guinea. These were described in his book "Walkabout", and briefly in *Man* (No. 121; 1936), while a detailed description of their material culture, written in collaboration with Miss K. Haddon, appeared in the *Journal of the Royal Anthropological Institute*, 66 (1936). Illustrated notes on some decorated shields and other specimens were published in the *British Museum Quarterly* (8, No. 129 and 11, No. 89).

Although written in narrative form, Lord Moyne's books, "Walkabout" and "Atlantic Circle", contain much scientific information, the value of which is increased by the accompanying photographs. There is also an introduction by the late Dr. A. C. Haddon and an appendix on the human crania by Dr. A. J. E. Cave in the former work. As an example of Lord Moyne's swiftness in action, it is worth mentioning that these volumes were each written and published within a few months of his return to England.

Lord Moyne had been for a number of years a fellow and a generous benefactor of the Royal Anthropological Institute, in the work of which he took a lively interest. He was elected a member of its Council in 1942. Only recently he had privately discussed his ideas for promoting archæological research in South America, particularly the highlands of Peru, either by an expedition or other means after the War. His untimely death has thus cut short a career in which his services to science, already considerable, would certainly have been continued and added to in the post-war years. H. J. BRAUNHOLTZ.

LORD MOYNE'S public activities left little time for detailed zoological work, but he had a life-long interest in the subject, and helped in many ways to advance our knowledge of general natural history and marine biology. He was for many years president of the Marine Biological Association and took a leading part in recent developments of the Plymouth Laboratory. In addition he was a valued member of the Council of the Zoological Society of London, and a generous donor to the collections in the Gardens.

Lord Moyne's main contributions to zoological science were the results of his yachting cruises to various parts of the world. On these he was generally accompanied by other naturalists, the Hon. Anthony Chaplin on the 1936 cruise, Captain Jean Delacour and Dr. John Colman in 1938, and Lady Broughton, whose excellent photographs help to illustrate his two books. Large and valuable collections of mammals, birds, reptiles, etc., were brought back either alive or carefully preserved, most of the live specimens being presented to the Zoological Society, and the preserved material to the British Museum (Natural History).

Among animals obtained on the cruise to New Guinea, a list of which is given in an appendix to "Walkabout", many, including two Komodo dragons, are still on view in the London Zoo. The collections of live animals brought back on this cruise alone and presented to Regent's Park included no less than sixteen species not previously exhibited in Britain.

All those who enjoyed the privilege of working with Lord Moyne have been impressed by his remarkable gifts, of which perhaps they will remember longest his thoroughness, his unfailing sincerity and his genius for friendship. EDWARD HINDLE.

WE regret to announce the following deaths:

Prof. D. MacCallum Blair, regius professor of anatomy in the University of Glasgow, on November 10, aged forty-eight.

Mr. E. V. Suckling, an authority on water purification and author, with J. F. Beale and J. C. Thresh, of "Examination of Water and Water-supplies", on November 16, aged fifty-one.

# NEWS and VIEWS

## Royal Society: Anniversary Meeting

THE customary anniversary meeting of the Royal Society took place on St. Andrew's Day, November 30, and the main part of the address by the president, Sir Henry Dale, is printed on p. 724 of this issue of *Nature*. In addition, Sir Henry referred to other matters, more of a domestic character. Prof. A. V. Hill's mission to India, to advise on science in general and a new programme of research and its applications, occupied the prominent place justified by the unqualified success which has attended it. A special meeting of the Royal Society was held in India, the first to be held outside Great Britain, and eventually a mission consisting of six of India's scientific leaders came to Britain, as the first stage of a tour extending to Canada and the United States, to see for themselves the scientific activities and organization with which the demands of war are being met and preparations being made for the tasks ahead in a largely devastated world. The members of the Indian mission used the rooms of the Royal Society as headquarters, and shortly before they left they were received by the King and Queen, who thus showed their interest in the promotion of closer understanding and comradeship in science between India, Great Britain and the whole of the British Empire.

Sir Henry Dale then turned to plans which are being made for increased provision for research in Great Britain. Last year he announced that the Royal Society had appointed a committee to consider the prospective needs of fundamental researches in physics. As the result of representations from other branches of science, a series of other committees was appointed, to consider the requirements in chemistry, biology, geology, geophysics, geography and mineralogy. The inquiries of these committees have been directed towards the advancement of knowledge without immediate or even implicit reference to practical needs or objectives; this was decided, not because of any inferior status or interest of applied research and related investigations, but because it is felt that such researches are already receiving support from the three Advisory Councils and are more likely to attract support from private benefactors. Sir Henry also referred to the problem of State accommodation for the principal scientific societies, with which he dealt in his address last year. The Royal Society was asked by several of the specialist societies to take up the matter, and a deputation was received by the Lord President of the Council, the Chancellor of the Exchequer and the Minister of Works and Buildings, on behalf of the Government. The case for the inclusion in any scheme for the rebuilding of London of a centre adequate to house the principal scientific societies was presented, and the deputation was asked to furnish quantitative data as a basis for further consideration of the question.

## Science and National Welfare

IN his address on receiving the Priestley Medal of the American Chemical Society on September 13, under the title "Science and the National Welfare" (*Chem. and Eng. News*, 22, 1642; 1944), Dr. J. B. Conant suggested that one of the many ills of the world seems to lie in the fact that certain aspects of accumulative knowledge, roughly what we call science, are often substituted for philosophy, while certain aspects of philosophy (a large part of the social sciences) are considered as science. If the United States is to live up to its responsibilities in the post-war years, it must foster all learning—accumulative knowledge, philosophy and poetry, including literature and the fine arts. So far as is humanly possible, all the potential talent in these manifold activities must be recognized at an early age and given adequate educational opportunity. Dealing more specifically with the physical sciences, Dr. Conant stressed the dependence, here as elsewhere, of the rate of advance on the number of really first-class men engaged, and he urged the institution of a national scholarship programme for young men who gave promise of becoming leaders in science and technology. For the most effective scientific advance in the applied fields, he believes there must be keen and strong rivalry between a number of strong and independent groups, but since we must look to the universities for the fundamental advances to be applied later and for the trained men required, industrial concerns and research institutes should beware of making too heavy demands on the universities for either time or their most promising men. Again, the mobile striking power of scientific talent required to exploit new advances resides ideally in the universities, but for the last twenty-five years the American universities had suffered from two great evils: their system of making life appointments, which so often fails to distinguish between men of real ability and men of medium competence; and the tendency to overburden the former with undergraduate teaching. Dr. Conant looks to the professional societies to play a leading part in forming the public opinion required to correct both these faults. With regard to funds, Dr. Conant believes it is more important for the universities to be able to find really first-rate investigators worthy of support than to find funds to support investigations.

## Scientific Film Association

THE first annual general meeting of the Scientific Film Association was held on November 25 in London. The chairman, Mr. Arthur Elton, proposing the adoption of the annual report, stressed the need for critical appreciation in the field of scientific films. He pointed out that the world of publishing has an elaborate organization for criticism and documentation of every book directly it is published; without some such machinery, the film will remain an ephemeral thing instead of being part of our national culture. He suggested that this deficiency in the scientific film might be made good by the Scientific Film Association, which is now publishing a catalogue of such films. Mr. Elton said that a North of England Section has been formed of the Association and that considerable interest has been shown in the United States and Canada. The Canadian Government has appointed a representative in Ottawa to cater for interest there in scientific films. Mr. Elton hopes that the Association will play its part in the international exchange of information by films. In the discussion which followed, members stressed the importance of developing the work of the standing committees of the Association dealing with medical, educational and industrial films. The problems of criticism and appraisal of scientific films were discussed and a request was made for specimen programmes for scientific film societies. A short film on Brownian movement made at the Glasgow Technical College, and the new film "Children of the City" and two

British Council films from the Central Film Library, "Life Cycle of the Maize" and "Development of the Rabbit", were shown.

## Russian Astronomy Resurgent

A TELEGRAM from Moscow gives the news that the Astronomical Council of the Academy of Sciences of the U.S.S.R. has already made a start on the task of rebuilding those Russian astronomical institutions which have suffered at German hands. Plans are being made both for the reconstruction of wrecked observatory buildings and for the design of new ones. A workshop under the direction of Prof. D. D. Midsutov, builder of the telescope with all-spherical surfaces, has been organized for the design of instruments and construction of scale models. The rebuilding of Poulkovo Observatory will begin in the near future: the new buildings, especially that which will house the great refractor, are designed to meet all the requirements of modern astronomical technique.

A site has been selected for the projected Central Asiatic Observatory on Zaili, a spur of the Ala Tau Mountains near Alma Ata. This observatory is not to be confused with the new astrophysical one, plans of which have already been drawn up, which in its scope and equipment is to be on a level with the best modern observatories. The site for this latter institution will probably be in the Crimea. The Ukrainian Academy of Sciences has decided to build a new observatory near Kiev, and Simeiz Observatory is already being rebuilt. In Moscow an astronomical laboratory is being established where visiting astronomers will be able to calibrate their photometric apparatus. The Leningrad Astronomical Institute will in future engage in purely theoretical work, including an attack on some problems in celestial mechanics, and will publish such periodical works as annual ephemerides.

## Total Solar Eclipse of June 9, 1945

A SOVIET broadcast announces that a commission set up by the Academy of Sciences of the U.S.S.R. to observe the total solar eclipse of June 9 next year has opened its first plenary session in Moscow. Prominent astronomers from Moscow, Leningrad, Kiev and other cities are taking part in the scheme. The band of totality passes from America through Norway, Sweden and Finland, crossing into Soviet territory near Lake Ladoga, and then stretching through Yaroslavl, Ivanovo, south of Gorki and Kuibyshev and north of Uralsk. The longest period of totality in the U.S.S.R. will be near Lake Ladoga, where it will last 61 seconds. Twenty Soviet expeditions are being organized. The Sternberg Astronomical Institute and similar bodies in Kiev, Kharkov and Kazan are to take part. Most of the sites of the expeditions are concentrated in the areas of Rybinsk and Yaroslavl. Preparations for observing the eclipse are also well forward in Sweden. A paper by Grönstrand, which is to appear in the *Annals* of the Stockholm Observatory, gives the circumstances of the eclipse in northern Sweden, and a party led by Lindblad plans to observe the flash spectrum.

## University of Melbourne

THE trustees of the estate of the late E. L. Baillieu have given the University of Melbourne £A105,000 for a new library to commemorate Mr. Baillieu's brother, the late W. L. Baillieu.

The following appointments have recently been made: Dr. L. H. Martin, formerly associate professor of physics in the University, but recently on leave for special duties under the Council for Scientific and Industrial Research, to be professor of physics; Dr. E. S. Hills, hitherto associate professor of geology in the University, to be professor of geology and mineralogy; Dr. S. Dattilo Rubbo, hitherto senior lecturer in bacteriology in the University, to be professor of bacteriology.

## Director of Army Education

BRIGADIER CYRIL LLOYD has been appointed director of army education under the Director-General, Mr. P. R. Morris. Brigadier Lloyd was educated at Brighton Grammar School and at the University of London, where he took his B.Sc. with first-class honours in 1926. He taught at Sir George Monoux Grammar School and later at Brighton Grammar School until the outbreak of war.

## Announcements

MR. D. A. OLIVER, research director of William Jessop and Sons, Ltd., and J. J. Saville and Co., Ltd., Sheffield, while continuing in this position, has also been appointed director of research to the Birmingham Small Arms Group, of which Jessops and Savilles form part. The B.S.A. Group research activities, in addition to being carried on in the existing laboratories situated at the different works of the Group, notably the Daimler Co., Ltd., Coventry, the B.S.A. Co., Ltd., Small Heath, Birmingham, and B.S.A. Tools, Ltd., Birmingham, are to be considerably expanded. Recent additions to the research staff include Dr. A. J. Bradley, formerly of the Cavendish Laboratory, Cambridge, and Mr. P. H. Lawrence, formerly of the Ministry of Aircraft Production, London.

THE Clough Memorial Research Fund, which was instituted in 1935 for the purpose of encouraging geological research in Scotland and the north of England, provides a sum of approximately £30 annually. Applications for grants are invited for the period April 1, 1945–March 31, 1946, and should state (1) the nature of the research to be undertaken; (2) the amount of grant desired; (3) the specific purpose for which the grant will be used, for example, travelling expenses, maintenance in field, excavation of critical sections, etc.; (4) whether any other grant-in-aid has been obtained or applied for. Applications must be in the hands of the Secretary, Clough Memorial Research Fund Committee, Edinburgh Geological Society, Synod Hall, Castle Terrace, Edinburgh, not later than March 1, 1945.

THE Summary of Current Technological Developments issued by the U.S. Department of Labour is prepared each month by the Productivity and Technological Development Division of the Bureau of Labour Statistics. Started at the end of 1941, it summarizes recent changes in processes, materials and manufacturing techniques as reported in current trade and technical periodicals, of which about two hundred are now covered each month. In addition to short abstracts of the articles or notes appearing in the periodicals cited, brief special reports are frequently presented on matters of current interest, based on a number of sources or on the work of the Division. The February 1944 issue, for example, includes a fifth article in a series on labour utilization, dealing with employee training and upgrading.

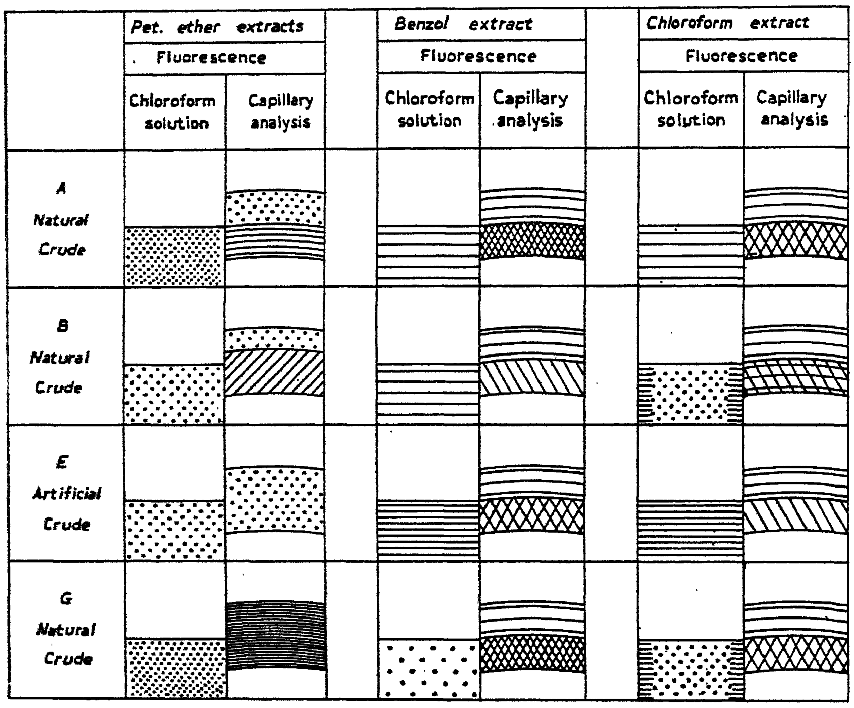
# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## A Method of Differentiation of Crude Oils based on Chromatography, Capillary Analysis and Fluorescence in Ultra-violet Light

CRUDE petroleum and the refined oils obtained from it fluoresce strongly in ultra-violet light. This property has recently been utilized for the differentiation of various types of crudes from one another and from refined oils or artificial mixtures prepared to resemble natural crudes[1 2 3]. The oil is either dissolved in a non-fluorescent solvent or spotted on a filter paper and fluorescence noted. Several crude oils from a particular field, some samples of refined oils, and two artificial crudes were examined using a Hanovia Universal fluorescence lamp as the source of ultra-violet light. The samples of refined oils could be readily distinguished from the crudes; but only minor differences were observed between the real and artificial crudes.

A technique based on the use of chromatography and capillary analysis on filter paper strips has been developed and found to be more satisfactory than fluorescence analysis of crude oils as such. The use of chromatographic adsorption analysis for testing asphalts and bitumens has recently been reported by Grader[4]. We adopted the following procedure. The chromatogram was formed on a column of Brockmann alumina from a dilute solution of the oil in petroleum ether (40–60° C.). After washing the column with the same solvent until a colourless filtrate appeared, it was dried by suction and then benzol percolated




*Blue ⁛ Yellow ≡ Brown \\\\ Red //// Greenish Yellow ////*
*Depth of colour indicated by closeness of symbols*

EXAMPLES OF FLUORESCENCE IN WASHINGS FROM ALUMINA.

| Sample* | Petroleum ether extract | | Benzol extract | | Chloroform extract | |
|---|---|---|---|---|---|---|
| | Fluorescence of chloroform solution | Fluorescence after capillary rise | Fluorescence of chloroform solution | Fluorescence after capillary rise | Fluorescence of chloroform solution | Fluorescence after capillary rise |
| *A* | Intense blue | Blue / Yellow | Light yellow | Light yellow / Deep reddish brown | Light yellow | Light yellow / Reddish brown |
| *B* | Blue | Blue / Greenish yellow | Very light yellow | Light yellow / Brown | Light blue with yellow fringe | Light yellow / Yellowish brown |
| *E* | Blue | Blue† | Yellow | Light yellow / Reddish brown | Yellow | Light yellow / Brown |
| *G* | Strong blue | Deep yellow | Light blue | Light yellow / Deep reddish brown | Blue with yellow fringe | Light yellow / Reddish brown |

* *A*, *B* and *G* were different natural crudes and *E* artificial crude.
† Characteristic of refined oil.

through it. The filtrate was collected in a separate receiver, and washing with benzol continued until a colourless filtrate was again obtained. This cycle of operations was repeated with chloroform. Different fractions of oils obtained by evaporating the extracts were dissolved in chloroform and the fluorescence of the solutions compared at equal concentrations. Capillary analysis was then carried out. Some results are given in the accompanying table and chart.

The oil samples gave blue fluorescence when dissolved in chloroform; but the fractions separated by chromatography showed marked differences in fluorescence colour.

These investigations have been carried out with the aid of a grant from the Assam Oil Co., Ltd. The method is being developed further. Our thanks are due to Mr. P. Evans and Mr. A. Reid for their help.

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[1] Bentz and Strobel, Proc. World Petroleum Congress, Vol. 1, 334 (1933).
[2] Balada, *Petroleum*, **31**, No. 48, 11 (1935).
[3] Fabian, *O.l. u. Kohle*, **39**, 631 (1943).
[4] Grader, *Oel. u. Kohle*, **38**, 867 (1942).

## Amides, Imides and Peptides

IN suggesting the term 'polypeptides' for describing condensates of amino-acids at large, Dr. Jordan Lloyd[1] is seemingly extending the meaning of the word beyond that originally proposed by Emil Fischer[2], who introduced it for the condensates of $\alpha$-amino-acids. Indeed, 'peptide' was not proposed for the link –CONH– but for the residue –CH*R*–CO–NH–, as is indicated by the use of 'dipeptide' for glycylglycine, which contains only one –CONH– group. Fischer, in his original lecture[3], put forward the proposal that by analogy with known distinctions made in carbohydrates between disaccharides, trisaccharides, etc., compounds of the glycylglycine type should be termed dipeptides and the higher condensates of amino-acids termed tripeptides, tetrapeptides, etc.

Dr. Jordan Lloyd's proposal, in addition to departing from Fischer's original conception which has been preserved in general usage, would bring within the scope of the term such polycondensates as those obtained from $\omega$-amino-acids, for example, $\omega$-aminocaproic acid. We agree that it is desirable to avoid confusion between proteins and nylons, but we think that Dr. Lloyd's suggestion would lead to more confusion in that it would not help in differentiating between condensates of $\alpha$-amino-acids and those of $\omega$-amino-acids, which must be classed as nylons[4].

It is misleading to say that nylon chemistry has its origins in organic chemistry: it is a part of organic chemistry, and not a different subject. Dr. Lloyd's complaint would seem to be based on a lack of knowledge of recent history. The word nylon is used as a short *generic* term[5] for what the inventor of the compounds, Carothers, described, prior to the introduction of the word nylon, as polyamides[6]; that is, the term polyamide is older than the term nylon.

To call the group –CO–NH– an amide or amido group is not wrong: to quote from the "Instructions to Abstractors" of the Chemical Society (see also ref. 7) "when . . . the $NH_2$ group is substituted with an acid residue such as acetyl it becomes acetamido, etc.".

Dr. Jordan Lloyd's definition of an imine as a compound containing the $>NH$ group only represents general usage when the group is part of a cyclic system, for example, as in ethylene-imine and *cyclo*-hexamethyleneimine, or present as a : C=NH group. Similarly, imides are *cyclic* secondary amides of dibasic acids[8].

We agree with Dr. Jordan Lloyd that it is not so easy to use existing terms, or to devise new terms, for purposes of classification in organic chemistry as it is in, for example, botany; but we do not agree that clarity will be brought into any relations when 'polyimide' is suggested as a general term with a definition which would seemingly include the well-known hydroxynaphthoic arylamides.

It is an objection to polyamide that it offers itself as a generic term also for the polymers of methacrylamide $CH_2 : C(CH_3)–CO.NH_2$ but, we think, few one-word terms are used without a context.

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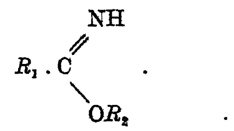
[1] Lloyd, D. Jordan, *Nature*, **154**, 486 (1944).
[2] Fischer, E., *Ber.*, **36**, 2094 (1903).
[3] *Chem.-Zeitung*, **26**, 939, No. 80 (1902).
[4] Brit. Pat. 461,236 and Brit. Pat. 461,237.
[5] Hoff, *Ind. Eng. Chem.*, **32**, 1560 (1940). Loasby, *J. Text. Inst.*, **34**, P 45 (1943).
[6] Carothers and Hill, *J. Amer. Chem. Soc.*, **54**, 1566 (1932), reproduced in "Collected Papers of Wallace Hume Carothers" (New York, 1944), p. 165.
[7] Smith, *J. Chem. Soc.*, 1076 (1936).
[8] Sidgwick's "Organic Chemistry of Nitrogen", Taylor and Baker, p. 152 (Oxford Univ. Press, 1942).

DR. JORDAN LLOYD is wrong in her conception of the nomenclature of imides and imines. While organic chemists will agree with her dictum that substances carrying the $–NH_2$ group are amines, those which carry the $>NH$ group are not necessarily imines. Thus, dimethylamine, $(CH_3)_2NH$, has such a group, and is still an amine; surely an imine must contain the structure $>C=N–$, as in the imino-ethers



With imides and amides the problem is similar; if Dr. Jordan Lloyd is correct in her view, any substance containing the –CONH– group would be an imide. Thus, on conversion of acetamide, $CH_3CONH_2$, to its methyl derivative $CH_3.CO.NH.CH_3$, a change in nomenclature would also take place, and the substance would be known as 'methyl acetimide'. This is quite in opposition to current practice and would be a most undesirable feature of nomenclature. Such substances are properly known as 'substituted amides'. The conception associated with imides dates from the recognition by Wurtz[2] in 1854 that amides could react as if derived from either of the structures I or II, and this persists in the 'lactam-lactim' nomen-

$R.CO.NH_2$ (I) $\quad R.C(=NH)OH$ (II)

clature used by Baeyer for the parallel case of isatin and its homologues.

It is clear that the term 'imine' should be confined to substances in which the $>C=N-$ is present, and that 'imide' should be reserved for derivatives of the enolic form of the amide structure and for the cyclic amides of dibasic acids. Substances of the structure $R_1CONHR_2$ should be termed 'substituted amides'. The term 'polyamide' for nylon is, therefore, correct.

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[1] *Nature*, **154**, 486 (1944).
[2] Wurtz, *Jahresb.*, 566 (1854).

IN reply to the above communications, I wish to say that the main point in my complaint is that in two closely allied fields of chemistry the connecting link –CONH– is being called by two different names, namely, 'amide' and 'peptide', and that the expression 'amide (or amido) group' is being used to cover both the connecting –CONH– and the terminal group $-CONH_2$, both of which are present in proteins.

For example, in a recent paper by P. J. Flory[1] dealing with three-dimensional polymers and the theory of gelation, in the section on protein gels he refers to "amide-amide hydrogen bonds" and quotes a paper by Myers and France. Reference to the latter paper[2] shows that these workers talk of hydrogen bond formation (with acetic acid) at "the loose ends of the salt-bridges after neutralisation has permitted them to separate", and of the "possibilities of hydrogen bond formation at each peptide link". They do not refer to 'amides' at all. When Dr. Astbury talks of an 'amide-hydroxyl' hydrogen bond in keratin, he means a side-chain link between the group $-CONH_2$ and OH.

Some of the correspondents also appreciate the difficulty. I am not an authority on organic nomenclature, and am willing to accept any ruling which would lead to clarity and be acceptable to the Chemical Society. As regards the past history of polypeptides and synthetic polyamides, this has not escaped my attention, but it does not of itself suggest how to deal with the future.

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[1] *J. Phys. Chem.*, **46**, 132 (1942).
[2] *J. Phys. Chem.*, **44**, 1113 (1940).

## Endocrine Reaction to Tissue Injury

IT has been reported previously that tissue damage produces in animals a state of resistance to the lethal effects of a subsequent trauma[1,2]. Resistance, as detected by the decrease in post-traumatic mortality, was accompanied by the following functional changes: inhibition of the normal release of histamine from blood cells[3]; shortening of the bleeding time; and increase of the capillary resistance[4]. All changes could be transferred to normal animals by injection of the serum of traumatized animals. It was also shown that the substance present in the serum and responsible for the resistance was produced by the pituitary and acted through the adrenal cortex[4].

Further investigations have been carried out, using the shortening of bleeding-time as test. Trauma, as well as injection of serum from traumatized animals, reduces the mean bleeding-time by about 40 per cent in groups of guinea pigs and rats. In hypophysectomized, adrenalectomized or splenectomized animals, however, neither trauma nor the injection of traumatic plasma produces a shortening of bleeding-time.

The part played by various tissues was further tested by studying the action of tissue extracts on bleeding-time. Of eighteen tissues investigated, only the extracts of pituitary, adrenals and spleen shortened bleeding-time. The same effect was observed with purified products from these organs: corticotrophic hormone of the pituitary and whole cortical extract (synthetic desoxycorticosterone was inactive). A spleen extract was prepared which shortened bleeding-time in a dose of 0·02 μgm. per kgm. body weight. Chemical identification of the latter is being attempted.

It has also been shown that the pituitary hormone is without effect in adrenalectomized or splenectomized animals. Adrenal extract had no action in the absence of the spleen, but spleen extract was still active in animals deprived of pituitary, adrenals or spleen.

Selye[5] observed hypertrophy of the adrenals in the 'adaptation' phase of the 'alarm reaction' which can be elicited by tissue injury. It is also known that adrenalectomized animals are particularly sensitive to 'shock' conditions[6]. The intervention of the pituitary in protection against these conditions was suggested by Reiss, Macleod and Golla[7]. Perla and Marmorston put forward the idea that the spleen might play a part in the resistance to infections[8]; but the facts mentioned above supply probably the first experimental proof of an endocrine function of the spleen.

The results of the experiments reported here point to the existence of a physiological mechanism responsible for the resistance to lethal effects of trauma. The pituitary responds to tissue damage by the secretion of corticotrophic hormone, which determines the release of an adrenal product stimulating eventually the secretion of the splenic substance. The mode of action of the latter is not yet known; some of its effects suggest either a change in the reactions of the capillary wall, reducing perhaps the escape of fluid into the tissues, or the inhibition of the release of toxic substances from certain cells.

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(French Scientific Mission
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Oxford.
Oct. 29.

[1] Noble, R. L., *Amer. J. Physiol.*, **138**, 346 (1943).
[2] Ungar, G., *Lancet*, i, 421 (1943).
[3] Ungar, G., *J. Physiol.*, **102**, 19P (1943).
[4] Ungar, G., in the press.
[5] Selye, H., *Endocrinology*, **21**, 169 (1937).
[6] Hechter, O., Krohn, L., and Harris, J., *Endocrin.*, **31**, 439 (1942).
[7] Reiss, M., Macleod, L. D., and Golla, Y. M. L., *J. Endocrin.*, **3**, 292 (1943).
[8] Perla, E., and Marmorston, J., "The Spleen and Resistance" (London: Baillière, 1935).

## A Crystalline Serum Muco-Protein with High Choline-Esterase Activity

In a recent article[1], Bader, Schütz and Stacey state: "It appears to be an undecided question whether choline-esterases from different tissues, such as blood and brain, are identical".

Bader and his associates must have failed to note that it has definitely been established that the cholinesterases from different tissues are not identical. The investigations reported by us[2] have conclusively demonstrated the existence of two distinct cholinesterases, a specific or true cholinesterase and a non-specific or pseudo-cholinesterase. Erythrocytes and brain[3] throughout the vertebrate kingdom contain true cholinesterase only, while a mixture of both enzymes is present in most of the sera[4] and tissues[3] of the many mammals investigated.

Furthermore, Bader and his co-workers report that they have isolated from horse serum a crystalline muco-protein with a cholinesterase activity 20–25 times higher than that of the original serum. As the purified enzyme preparations from horse serum described by one of us[5] are about three hundred times more active than their crystals, it seems likely that at least 299 out of 300 parts of these crystals, that is, 99·7 per cent, represent inert material.

Since Bader *et al.* are inclined to the view that the great discrepancy between their results and our own might be due to the use of different methods of assay, we feel that an exchange of samples, giving both parties an opportunity of comparing the activity of the two preparations by their own test, would be the most satisfactory solution of the controversy.

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H. RUDNEY.
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University of Toronto.

[1] Bader, R., Schütz, F., and Stacey, M., *Nature*, **154**, 183 (1944).
[2] Mendel, B., and Rudney, H., *Biochem. J.*, **37**, 59 (1943).
[3] Mendel, B., and Rudney, H., *Science*, **98**, 201 (1943).
[4] Mendel, B., Mundell, D., and Rudney, H., *Biochem. J.*, **37**, 473 (1943).
[5] Strelitz, F., *Biochem. J.*, **38**, 86 (1944).

## An Effect of Overdosage with Corticotrophic Pituitary Extract on the Rat Kidney

Recent progress in the purification of the corticotrophic fraction of the anterior pituitary lobe (the preparations contain 24–48 cortic-lipoid units per mgm.) has made it possible to inject rats with very large doses of this hormone. While investigating the effect of such large doses, it was noticed that the kidneys of animals intraperitoneally injected with a dose exceeding 100 units presented a picture which differed considerably from that of the kidneys of the control rats.

Kidneys of rats injected with the corticotrophic hormone showed the following abnormalities. Macroscopically, the kidneys appear pale, mottled and swollen, with a tense capsule. This observation was borne out by a comparison of the weight of kidneys of injected animals with that of the kidneys of controls. It will be seen from the accompanying table that, after injection of doses of corticotrophic hormone ranging from 4 to 24 mgm., weight increases of 14–46 per cent have been found.

| Treatment | No. of rats | Combined body weight of whole group (gm.) | Combined weight of kidneys (gm.) | Combined weight of kidneys as per cent of combined body weight | Increase in kidney weight (per cent) |
|---|---|---|---|---|---|
| Controls | 3 | 125 | 1·77 | 1·41 | |
| 24 hours after 8 mgm. intraperit. | 3 | 121 | 2·32 | 1·91 | +35·5 |
| Controls | 3 | 135 | 1·74 | 1·29 | |
| 5 hours after 4 mgm. intraperit. | 3 | 145 | 2·45 | 1·69 | +32 |
| 3×4 mgm. in 48 hours | 3 | 126 | 2·38 | 1·89 | +46·5 |
| Controls | 3 | 129 | 1·8 | 1·39 | |
| 3×4 mgm. in 48 hours | 3 | 122 | 2·1 | 1·68 | +22·4 |
| 6×4 mgm. in 72 hours | 3 | 133 | 2·6 | 1·92 | +38·1 |
| 5 hours after 12 mgm. intraperit. | 3 | 132 | 2·21 | 1·59 | +14·4 |

*Histological findings.* In kidneys of rats injected with 1 mgm. of extract per animal and killed after 12 hours, the main pathological change consists in a patchy necrosis of the tubules of the glomerular zone of the cortex (see photomicrograph). There is marked swelling of the tubular epithelium, usually sufficient to obliterate the lumen, nuclei are absent or shrunken and pyknotic, and the cytoplasm stains a light pink with eosin without showing the granularity of cloudy swelling. Staining with Sudan III or IV shows deposits of lipoid granules in a minority of these tubules; but fatty change is not a conspicuous feature, nor do these kidneys contain anisotropic lipoid. The glomeruli are somewhat enlarged and may exhibit a slight cellular swelling and capillary dilatation. With larger doses (for example, 8 mgm. after 12 hours) in addition to the changes described above, which are now more marked in the case of the glomeruli, there are larger areas of infarction, with necrosis of all elements of the cortex, corresponding to the areas of hæmorrhage observed macroscopically.

The changes described could be seen as early as five hours after injection of the high doses of the corticotrophic hormone, and they seem to be fully developed twelve hours after the hormone administration.

NECROSIS OF TUBULES IN THE GLOMERULAR ZONE OF THE CORTEX OF RAT KIDNEY 12 HOURS AFTER 1 MGM. EXTRACT INTRAPERITONEALLY. EHRLICH'S HÆMATOXYLIN AND EOSIN. × 270.

Considerably larger doses of egg albumen, peptone and dried whole pituitary gland suspensions failed to produce similar changes in control animals.

In a further series of experiments, a number of epinephrectomized rats were injected with high doses of the corticotrophic hormone preparation. The kidneys of some of these animals showed similar though less pronounced changes to those observed in rats with intact adrenals.

The occurrence of these kidney changes after injection of the hormone might be ascribed to either of two factors, if it is possible to rule out a direct toxic action due to the concentration of some substance during the process of purification. These possibilities are: (*a*) an effect of the anterior pituitary hormone on the accessory adrenals; (*b*) a direct action of the purified corticotrophic hormone on the kidneys.

The first possibility would appear to be more acceptable, as Selye[1], with overdosage of desoxycorticosterone acetate, has produced nephrosclerotic changes in the kidneys of young chicks. Other investigations[2] point in the same direction.

It may also be remembered that pathological changes of the kidneys and the kidney function have been observed in cases of Cushing's syndrome, a disease in which a hyperexcretion of corticotrophic hormone[3] and of cortine[4] has been demonstrated.

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[1] Selye, H., *Canad. Med. Assoc. J.*, **47**, 515 (1942).

[2] Winter, C. A., and Ingram, W. R., *Amer. J. Physiol.*, **139**, 710 (1943); *Federation Proc.*, **2**, 55 (1943). Clinton, jun., M., and Thorn, G. W., *Science*, **96**, 343 (1942). Spingarn, C., Mulinos, M. G., and Maculla, E., *Federation Proc.*, **2**, 93 (1943). Harned, A. S., and Nelson, W. O., *Federation Proc.*, **2**, 19 (1943). Piantoni, C., and Orías, O., *Rev. soc. argentina biol.*, **18**, 326 (1942).

[3] Jores, A., *Z. exp. Med.*, **97**, 622 (1936). Reiss, M., *Klin. Wochenschr.*, **16**, 937 (1937); *J. Ment. Sci.* (July 1939).

[4] Anderson, E., Haymaker, W., and Joseph, M., *Endocrinol.*, **23**, 398 (1938).

## Optical Phenomena in the Atmosphere

THE "Solar Halo Phenomenon" described by G. H. Archenhold in *Nature* of September 30 was referred to in recent correspondence in *The Times* and was explained in a short article by me in *The Times* of August 31. The occurrences of August 9 seem to have been particularly striking.

Accounts from meteorological observers have made it fairly certain that the "dark bands moving like waves" or ripples across solar optical phenomena are connected with sound waves from explosions. I saw some in France during the War of 1914–18 on the occasion of a series of big explosions, though at that time the connexion with sound waves was not appreciated[1].

It seems that the sound waves passing through the air can affect two types of optical phenomena: (1) the type such as iridescence which depends on diffraction of light through minute water droplets; and (2) the type depending on reflexions in ice crystals floating with their axes in a fixed direction.

In the first type, as a result of the sequence of adiabatic warmings and coolings produced in the cloud by the explosion waves, the sizes of the cloud droplets diminish and increase respectively. With the changes in the size of the cloud particles, changes in the interference colours and thus in the iridescence are brought about. It might at first sight seem that changes in size of water drops could not take place sufficiently quickly to render sound waves visible in this way; but according to theoretical calculations made by Findeisen and experiments on artificial fogs made by H. Mache about 1933, the rate of evaporation of water droplets can actually be sufficiently great in the very small droplets characteristic of thin, newly formed clouds.

In the ice crystal type of phenomenon, it is presumably the momentary displacements caused by the explosion waves in the lie of the crystal axes which cause the ripple effect. The angular speed of the ripples mentioned by G. H. Archenhold (5° per second) would give the velocity of sound at a distance of some 12,000 feet, though the height of the cloud trail was much more likely to have been about twice as great. The band width mentioned ($\frac{1}{8}$°) or the distance between bands ($\frac{1}{2}$°–1°) would correspond to a very low frequency sound which, however, is a characteristic of heavy explosions.

It may be relevant to mention here another kind of optical phenomenon which has recently been described in letters to *The Times* and discussed in an article on September 3 under the heading of "Flying Bomb Waves". Such waves have been seen by observers of nearby explosions and have been described as "a faint but distinct line in the form of a seemingly perfect arc centred on the spot where a bomb had disappeared". These effects are connected with the explosion wave within a few hundred yards of the explosion itself, and it seems that the curved line represents the hemispherical wave of compressed air. In this case the optical effect might arise either from evaporation of water droplets in cloudy air or even as a refraction (mirage) effect from the relatively steep gradient of air density. Calculation of the effect produced by a ton of high explosive suggests that either effect is physically possible up to a radius of the order of 500 yards from the exploding bomb, provided the bomb explodes before burying itself in the ground or in buildings, and assuming the observer to be suitably placed—say, half a mile distant—to view the effect.

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[1] *Q. J. Roy. Met. Soc.*, **45**, 366 (1919).

THE arc through the sun described by Mr. C. J. P. Cave[1] can only, I fear, be identified with the horizontal circle and not with some rare tilted arc. Its identity is clear from the fact that it passed both through the sun and through the parhelia to the 22° halo, which have the same altitude as the sun. The impression of upward tilting, due to perspective, was unquestionably enhanced by the comparatively high sun and the small amount of the circle that was visible; a lower sun and a more extensive development of the circle make it clear that all parts of it are the same distance from the horizon. The apparent tilting is an effect with which Mr. Cave will certainly be familiar from observations of clouds.

I have advisedly used the word 'tilted', since the word 'vertical' is inadmissible in the sense used by Mr. Cave. Haloes are, of course, simply rays of light

with a particular orientation to the eye, but for convenience we regard them as having a definite location. The 22° halo, generally seen as a circle normal to the line from the sun to the eye, if seen in hoar frost soon after sunrise is so obviously on the ground that we say it is a horizontal hyperbola. Similarly the rainbow, when seen as a dewbow on ponds covered with an oily film, on cobwebs, or on delicate new-sown grass, becomes an ellipse. In general, halo phenomena are regarded as projected on the celestial sphere. A little consideration makes it clear that a horizontal circle through the sun, as it is progressively raised on the side away from the sun, becomes steadily smaller and finally disappears when its inclination to the horizontal is equal to the zenith distance of the sun.

Although the number of observations is too small to allow definite conclusions, it is of interest to note that the four well-developed horizontal circles that I have observed have all been in small cirro-stratus sheets far below the ordinary cirrus level, at some 5,000 ft. or less; of trace observations, one has been at low level in ice-crystal fog, three at high level, and three at doubtful heights. The brief life and sudden appearance and disappearance of Mr. Cave's display suggest a low level, and consequent high angular velocity, of the cloud.

The occurrence of these arcs in cloud believed to have originated from condensation trails is of interest to me because such trails sometimes seem to yield no arcs, which suggests that they may be made up of very small crystals, complex crystals, or sub-cooled droplets. Of nine sets of trails seen, five did not approach the sun, three yielded no arcs, and one yielded a brilliant circumzenithal arc. The aircraft that formed the latter trail was estimated to be flying at 3,000 ft. and a thin ice-crystal haze was present at the same general level, since a faint circumzenithal arc was present below small patches of alto-cumulus. It may be significant that the two possible orientations of crystals forming this arc (vertical axis of symmetry, and horizontal axis of symmetry with two side faces horizontal) are two of the possible orientations of crystals forming the horizontal circle (vertical axis of symmetry, horizontal axis with two side faces horizontal, horizontal axis with two side faces vertical, and horizontal axis with side faces randomly oriented). Perhaps readers in Britain, where condensation trails must have been only too common in the last five years, can give more information on optical effects in this type of cloud.

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[1] *Nature*, **154**, 240 (1944).

THE letter of Dr. Savile and private correspondence I have had with Dr. Paul White convinces me that I must have been mistaken, and that what I saw on May 2 was a small part of the parhelic circle.

No doubt 'tilted' is a better word to use in connexion with halo phenomena than 'vertical'; but the latter term has been in use for a long time and did not originate from me.

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## Cryoscopy of Solutions

A. V. Brancker, S. J. Leach and V. A. Daniels suggest[1] that $\theta$, the depression of the freezing point of a solvent by a solute of $m$ molal concentration, can be given by $\theta = Km^b$, where $K$ is the cryoscopic constant and $b$ a constant very nearly unity.

Such a relation, admittedly empirical, is fundamentally of an incorrect form because it cannot lead to the necessary thermodynamic requirement that $\theta/m$ is finite when $m = 0$, and furthermore, $K$ so defined is a cryoscopic constant at unit molality, a quantity smaller than the limiting or van't Hoff value. The ability of this relation to accommodate data over a wide range of concentration from 0 to 1 molal is apparent only. This agreement exists because $d\theta/dm$ and $\theta/m$, although identical at $m = 0$, diverge very slowly with increasing concentration, and $b$ is the ratio of these quantities.

It can be shown thermodynamically, for solutions obeying Raoult's law, that $m = \alpha\theta + \beta\theta^2 + \gamma\theta^3 + \ldots$, where $\alpha$ is the reciprocal of the van't Hoff constant, $\beta$ and $\gamma$ are functions of heat of fusion and its temperature coefficient. From this it follows that $b$ is given by $d \log \theta / d \log m = (\alpha + \beta\theta + \gamma\theta^2)/(\alpha + 2\beta\theta + 3\gamma\theta^2)$, a function rather insensitive to variation in $\theta$ because of the relative magnitudes of $\alpha$, $\beta$ and $\gamma$. This small variation is illustrated well by ideal benzene solutions, for which $m = 0{\cdot}1953\theta + 2{\cdot}4 \times 10^{-3}\theta^2 + 1{\cdot}4 \times 10^{-5}\theta^3$. This leads to values of $b$ varying from 1 to 0·945 for concentrations from 0 to 1 molal respectively. Non-ideal solutions can be represented in a similar form with different coefficients and slightly smaller values of $b$. Such variations in slope would be barely noticeable in a logarithmic plot of the empirical relation, and most certainly tend to be masked by experimental variation in $\theta$.

There remains to discuss the experimentally observed decrease in $\theta/m$ with increasing concentration. Many of the reported anomalies in the literature can doubtless be attributed to the use of the van't Hoff limiting constant at finite concentrations. Rigid calculation shows that, for ideal benzene solutions, we must expect $\theta/m$ to change from 5·122 at $m = 0$ to 4·81 at $m = 1{\cdot}0$ molal. The effect of applying the limiting constant to ideal solutions of a substance of formula weight 100 would be to give an apparent value of 107·5 at 1 molal. For non-ideal solutions such variations will be even larger.

The data given for solutions of tetralin in benzene[1] show anomalies which are too large to be so explained.

1. Low concentrations give $\theta/m$ already in excess of the accepted limiting value 5·122, a value expected from thermal data and corroborated by the careful and extensive measurements of Bury and Jenkins[2] on the freezing points of numerous benzene solutions.

2. The molecular weight of tetralin found is 136 instead of 132·2 which its formula requires.

These abnormalities are removed if one assumes that insufficient precaution was taken to prevent access of moisture to the benzene during the measurement. Assuming these solutions to be saturated with water (0·0335 per cent at 5·4° C.)[3], then approximately the observed depressions are too high by 0·120° C. Making this correction gives the values $\theta/m$ in column 4 (below). Excluding the value at the lowest concentration, which appears to be in error, $\theta/m$ now shows a variation with concentration which is quite close to the values calculated for an ideal solution and shown in column 5.

The data extrapolate to $\theta/m = 5{\cdot}1$. Assuming

this value, molecular weights so calculated are given in column 6. These show a small variation with concentration, which extrapolates to a value lying between 132 and 133.

| Tetralin (molal) | $\theta$ corr. | $(\theta/m)$ uncorr. | $(\theta/m)$ corr. | $(\theta/m)$ calc. | $M$ |
|---|---|---|---|---|---|
| 0·8422 | 4·196 | 5·120 | 4·982 | 4·86 | 135·2 |
| 0·6008 | 3·045 | 5·267 | 5·069 | 4·93 | 132·9 |
| 0·3008 | 1·516 | 5·441 | 5·040 | 5·03 | 133·9 |
| 0·1495 | 0·756 | 5·359 | 5·056 | 5·07 | 133·6 |
| 0·0518 | (0·201) | (6·197) | (3·880) | — | (172·6) |
| | Extrapolated | | 5·1 | 5·12 | 132–133 |

The abnormal data for camphor given by Meldrum, Saxer and Jones[4] can also be explained by assuming the presence of some impurity. This is the explanation offered by Ricci[5]. Another possible source of error is the loss of camphor by sublimation during measurement.

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[1] *Nature*, **153**, 407 (1944).
[2] *J. Chem. Soc.*, 688 (1934).
[3] "Int. Crit. Tables", **3**, 389.
[4] *J. Amer. Chem. Soc.*, **65**, 2023 (1943).
[5] *J. Amer. Chem. Soc.*, **66**, 658 (1944).

THE exact equation for an ideal solution has the form

$$d \log x/dt = \frac{\Delta H}{RT^2}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (1)$$

where $x$ is the mol. fraction of the solvent and $\Delta H$ is the molar latent heat of fusion.

It can be shown that the classical equation

$$\theta = Km \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where $m$ is the molality results from two main approximations applied in the reduction of (1) to (2), and it has been assumed in the literature that the variation in $\theta/m$ found with (2) is due to these approximations.

Banks has now shown that $\theta/m$ still varies even when an accurate expression derived from (1) is obtained, namely,

$$m = \alpha\theta + \beta^1\theta^2 + \gamma^1\theta^3 \quad . \quad . \quad . \quad . \quad (3)$$

Using equation 2, $K$ found experimentally falls from an abnormally high value at $m = 0$, approaching the thermodynamic figure at $m = 1$.

Equation 3 likewise shows a fall in the value of $\theta/m$, but in this case $K$ is defined at $m = 0$. Because of the difficulty in obtaining experimental data at low concentrations and therefore extrapolating to infinite dilution, we evolved the empirically deduced equation:

$$\theta = Km^b \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

For the ideal case studied by Banks, $b$ has been found to vary, but as he has pointed out, the order of this variation is such as to be masked by experimental error. From the practical point of view, therefore, this variation must be insignificant.

If, as it has been suggested, the abnormal results of Meldrum, Saxer and Jones were due to sublimation or impurities in the camphor, then we should have to accept the untenable conclusion that in our confirmatory work on camphor the same amount of sublimation and the same unspecified impurities were present. Further, the experimental results on which equation (4) is based have been checked by plotting $\log x$ against $1/T$, and the slopes of the lines obtained at any point gave latent heats of fusion of the solvents in close agreement with the literature values.

Finally, we have applied the moisture correction of 0·120° C. to the tetralin results; also to solutions of naphthalene in a different sample of benzene:

Tetralin: $b = 0·9394$

| Concentration (gm. per 100 gm. solvent) | Molality | $\theta$ | $\theta$ corrected | $\theta$ corr./$m$ | $\frac{\theta}{m^b}$ |
|---|---|---|---|---|---|
| 0·685 | 0·0518 | 0·321 | 0·201 | 3·880 | 5·180 |
| 1·977 | 0·1495 | 0·876 | 0·756 | 5·056 | 5·220 |
| 3·976 | 0·3008 | 1·636 | 1·516 | 5·040 | 5·169 |
| 7·942 | 0·6008 | 3·165 | 3·045 | 5·069 | 5·107 |
| 11·134 | 0·8422 | 4·316 | 4·196 | 4·982 | 5·072 |

Naphthalene: $b = 0·9846$

| Concentration (gm. per 100 gm. solvent) | Molality | $\theta$ | $\theta$ corrected | $\theta$ corr./$m$ | $\frac{\theta}{m^b}$ |
|---|---|---|---|---|---|
| 0·653 | 0·0510 | 0·279 | 0·159 | 3·118 | 5·225 |
| 0·922 | 0·0720 | 0·390 | 0·270 | 3·750 | 5·201 |
| 1·126 | 0·0880 | 0·477 | 0·357 | 4·058 | 5·223 |
| 3·430 | 0·2680 | 1·452 | 1·332 | 4·970 | 5·310 |
| 7·181 | 0·5610 | 2·922 | 2·802 | 4·995 | 5·162 |
| 10·160 | 0·7938 | 4·162 | 4·042 | 5·092 | 5·225 |

If the moisture correction were valid and could be accepted as the explanation of the anomaly found by using (2), then the results given in column 5 of the above table should extrapolate to 5·12 at $m = 0$.

In view, however, of the results obtained with naphthalene, we cannot conclude that the water correction can be used as an explanation of the anomaly. The values of $\theta/m^b$, however, approximate to a constant value for $K$, which we believe can be used in actual determinations of molecular weights.

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## Commutation of Annual Subscriptions

DR. HERON's letter in *Nature* of September 23 should be of special interest to British scientific men, in that commutation gets over the legal anomaly that subscriptions to technical societies are not chargeable as expenses for the purposes of income tax, unless the taxpayer is working on his own. Those paid by salary cannot enter subscriptions as an expense, even when appointment is conditional on membership of some appropriate technical institution.

The difficulty is eliminated because commutation is equivalent to buying an annuity for the amount of the annual subscription, without the member becoming liable to tax on the capital part of the annuity; and also to tax on the income part, if the body happens to come within the rather artificial legal definition of a charity, and most technical ones do so. With non-charitable bodies commutation fees should necessarily be higher, in that tax has to be paid on the income from the commutation fund.

The fact is that it almost always pays for good lives to commute, even when the purpose is not to avoid income tax; for there is a general tendency to fix commutation fees too low, even in relation to the current annual subscription. Actually the fees should make some provision for the possibility of future rise in annual subscription, necessitated not only on account of the tendency for the value of money to fall in the course of years, but also by the desire of any active institution to widen the scope of its activities, for the general benefit of its members.

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# RODS AND CONES, AND THOMAS YOUNG'S THEORY OF COLOUR VISION

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MR. E. N. WILLMER'S recent communications[1,2] on the physiology of colour vision once more direct attention to the essential principles involved in Thomas Young's theory. As is well known, it is on purely logical grounds that Young in 1801 came to the conclusion that the existence of three kinds of receptors having different spectral sensitivities—as we would say to-day—should account for the facts of normal colour vision[3]. At the basis of the theory lies[4] the principle of the 'specific energy of nerves', formulated by J. Müller[5] in 1840, according to which each nerve fibre can send only one kind of sensory message to the brain. This would seem to lead to the conclusion that there must be as many different kinds of receptors as there are colours; but Young's well-known hypothesis allows this number to be reduced to three. For the abnormal colour vision of such persons as his contemporary Dalton, Young himself suggested as an explanation "the absence or paralysis of those fibres of the retina which are calculated to perceive red"[6]; that is, dichromats would possess only two colour receptors instead of three. To-day the strength of this theoretical argument referring to the whole retina remains undiminished[7,8,9,10].

Meanwhile, however, as the properties of the actual retinal receptors became better known, the duplicity theory was evolved. According to it, the rods mediate only a colourless kind of vision, while colour vision is entirely mediated by the cones[11]. If this is the case, then Young's reasoning must be applied to the cones, leading to the conclusion that there are three different kinds of cones. Now, however, Mr. Willmer[1,2] has made the radically different suggestion that the rods constitute one of the kinds of receptors which mediate colour vision. It seemed advisable, therefore, to make some new experiments on the response to coloured lights of rod-free and rod-containing regions of the retina when the eye is completely dark-adapted, that is, when the sensitivity of the rods is greatest.

Two observers whose colour vision is normal according to the Ishihara test were used. The observer's right eye viewed a small red fixation point through a 2 mm. artificial pupil. The test field, the diameter of which subtended an angle of 10′ at the eye, was constituted by the surface of an opal electric bulb seen through a small circular opening. It was exposed in flashes of 0·04 sec. It could be presented at various distances from the fixation point on the horizontal meridian. Violet light was obtained using Corning filter 511, which transmits only below 470 mμ; red light, using Wratten filter 88, which transmits only beyond 700 mμ. The light intensity could be changed by using a system of two neutral wedges calibrated for these lights. The brightness of the test field was calculated from the colour temperature of the light source, the spectral transmission of the filters, the I.C.I. photopic visibility curve and the brightness of the opal bulb. The latter brightness is not very accurately known, but this is of little importance here, for the error would affect all threshold values by the same amount. Using this arrangement, the absolute threshold (brightness at which the stimulus is seen with a 50 per cent frequency) was determined in various regions of the dark-adapted fovea and parafovea.

Fig. 1 shows the results of a typical experiment. For violet light, the threshold decreases slightly as the angular distance between test field and fixation point increases from 0·15° to 0·75°. Then it drops suddenly and at 3·75° it is about 2 log units lower than near the centre of the fovea. At angles up to 0·75°, both observers reported that the field, when seen at all, appeared of a deep violet or blue colour; at the higher angles it always appeared colourless. For red light the threshold value changes little with the angle, being slightly higher at higher angles. When it was seen, the test field always appeared red. In the central region, the present results differ from those of Wentworth[12] who, using a larger test field (1° 16′ in diameter), found an achromatic threshold lower than the chromatic threshold. The present results for extreme red are similar to those of Mandelbaum[13].

Fig. 2 reproduces the distribution of rods and cones in a human retina studied by Østerberg[14]. The central region contains only cones, the first rods appearing at an angle of about 0·34°. The number of rods per unit area goes on increasing while the number of cones decreases, the two numbers being

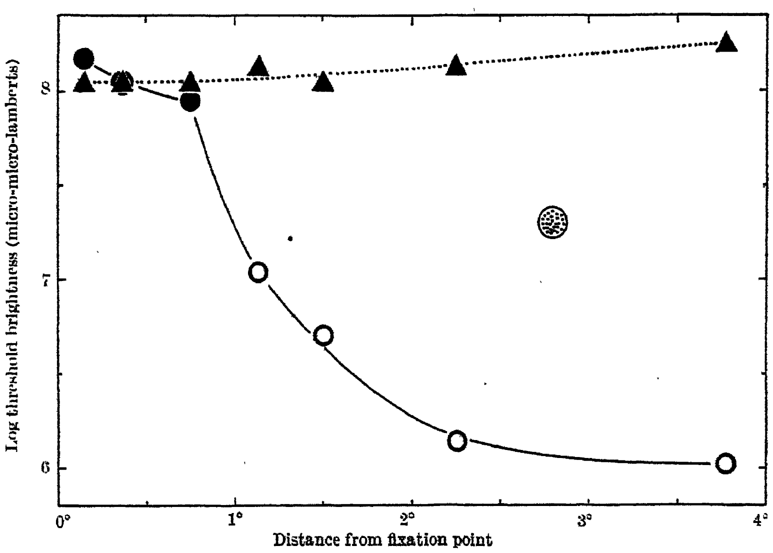


Fig. 1. THRESHOLD VALUES FOR EXTREME BLUE (SMALL CIRCLES) AND EXTREME RED LIGHT (TRIANGLES) IN VARIOUS PARTS OF THE RETINA, TEMPORALLY TO THE FIXATION POINT.

The full circles and triangles correspond to coloured vision; the open circles to colourless vision. The large dotted circle represents the dimensions of the test field.

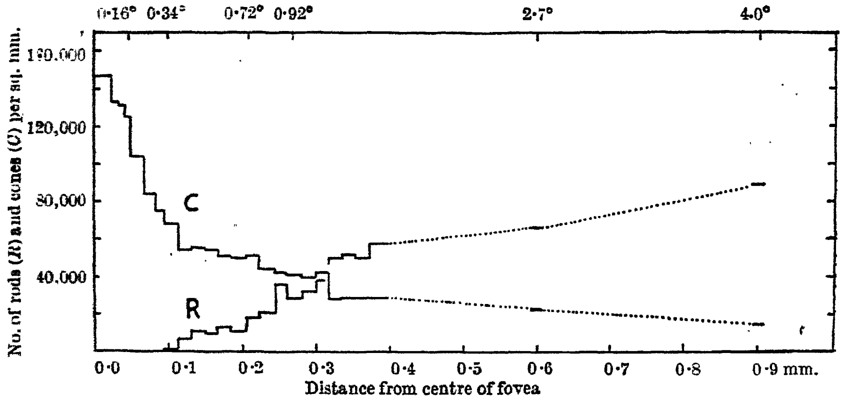


Fig. 2. DISTRIBUTION OF RODS AND CONES IN THE CENTRAL PART OF A HUMAN RETINA, FROM THE DATA OF ØSTERBERG[14].

The distances in mm. are uncorrected for shrinkage of the preparation (multiply by 1·31 to obtain the real distances). The corresponding distances in perimetric degrees have been calculated by Østerberg.

Perfect correspondence between Figs. 1 and 2, of course, cannot be assumed, since they refer to different eyes.

equal at an angle of about 1°. Comparison of Figs. 1 and 2 clearly shows that, for violet light, the threshold is high and the light is seen coloured in the rod-free area, while the threshold is much lower and the light appears colourless in the area where the rods are considerably more numerous than the cones, that is, at angles larger than 2°. In the intermediate region, the passage from coloured to colourless vision occurs only at an angle where the rods are fairly numerous, as might have been expected. For red light, the presence or absence of rods has little influence on the value of the threshold or on the colour of the light in the region studied here (at an angle of 7·5°, however, the light appeared orange).

These results are in full agreement with the duplicity theory[11,15,16]. With regard to the special problem of colour vision, it can be concluded that, under the present conditions, the rod-free area of the fovea is the best region for colour vision. The rods are not necessary for colour vision: on the contrary, where they are present in fair numbers, the colour of the violet test field vanishes.

It might be objected, however, that the colour vision mediated by the central rod-free area under these conditions may not be the same as normal colour vision in the light-adapted eye, and perhaps has not the properties to be expected from a three-receptor system. That this region contains at least two kinds of receptors is shown by the fact that red and blue are clearly differentiated: for, if it contained only one kind of receptors, there could be no wave-length discrimination at all. But it has been suggested[2] that it might contain only two kinds of receptors. In that case, using small fields falling inside the rod-free area, it should be possible to match any wave-length or mixture of wave-lengths with mixtures of red and blue in suitable proportion. I tried to test this, using an improvised apparatus, but no definite results were obtained. It was found that some red-blue mixtures become difficult to differentiate from yellow, but it was not certain whether the hues of the two test fields really became indistinguishable. Hue discrimination becomes poor when the test fields are small[17]. This well-known effect, and the imperfections of the apparatus, may or may not account entirely for the fact that at times a match appeared to be obtained. Experiments with a good colour-mixing apparatus are needed to settle this question.

As the assumption that there are only two kinds of receptors leads to conclusions at variance with the facts of normal colour vision, Young's theory asserts that at least three kinds of receptors—whatever they may be—must exist. On the other hand, the conclusions derived from the two-receptor assumption are in agreement with the observations made on dichromats. This provides a more positive kind of evidence in favour of the theory, and this evidence is perhaps more complete than is generally supposed. As is well recognized, if there are only two kinds of receptors there must be one wave-length—the neutral point in the spectrum of the dichromats—which stimulates the two receptors precisely in the same ratio as composite white light does. Now, on the short wave-length side of this neutral point, the stimulation by any wave-length must be the same as that by white light plus, say, 440 mμ; on the other side of the neutral point, by white plus, say, 650 mμ. In either of these parts of the spectrum, therefore, saturation changes must be the sole basis for wave-length discrimination and colour matching. This is precisely what has been found in a relatively recent investigation of the vision of dichromats[18]. The same situation should also be expected to exist in the rod-free area of normal subjects if this area is really a two-receptor system.

I am indebted to Prof. F. C. Bartlett for the hospitality he gave me in his laboratory. The experiments reported here were made in January and March 1944, with Mr. Willmer, whom I wish to thank for acting as a subject. The apparatus which was used is the property of the Medical Research Council.


[1] Willmer, E. N., *Nature*, **151**, 213 and 632 (1943).
[2] Willmer, E. N., *Nature*, **153**, 774 (1944).
[3] Young, T., "On the Theory of Light and Colours", *Phil. Trans. Roy. Soc.*, Part 1, 20 (1802). Reprinted in "Lectures on Natural Philosophy", **2**, 613 (London, 1807).
[4] König, A., "Gesammelte Abhandlungen zur Physiologischen Optik", 88 (Leipzig, 1903).
[5] Müller, J., "Handbuch der Physiologie des Menschen" (Coblenz, 1840).
[6] Young, T., note in the "Catalogue" in "Lectures on Natural Philosophy", **2**, 315 (London, 1807).
[7] Craik, K. J. W., *Nature*, **151**, 727 (1943).
[8] Hartridge, H., *Nature*, **151**, 432 (1943); **152**, 190 (1943); **153**, 45 (1944).
[9] Hecht, S., *J. Opt. Soc. Amer.*, **20**, 231 (1930).
[10] Holbourn, A. H. S., *Nature*, **152**, 190 (1943).
[11] Hecht, S., *Physiol. Rev.*, **17**, 239 (1937).
[12] Wentworth, H. A., *Psychological Monographs*, **40** (1930).
[13] Mandelbaum, J., *Arch. of Ophtalm.*, **26**, 203 (1941).
[14] Østerberg, G., *Acta Ophtalm.*, Suppl. 6 (Copenhagen, 1935).
[15] Walters, H. V., and Wright, W. D., *Proc. Roy. Soc.*, B, **131**, 340 (1943).
[16] Wright, W. D., *Nature*, **151**, 726 (1943).
[17] Helmholtz, H. von, "Physiologische Optik", 2nd ed., 374 (Hamburg and Leipzig, 1896).
[18] Hecht, S., and Shlaer, S., *J. Gen. Physiol.*, **20**, 83 (1936).

# STATUS OF PROFESSIONAL CIVIL SERVANTS

THE recommendations of the Emergency Executive Committee of the Institution of Professional Civil Servants, which it is claimed represents more than 30,000 members of all grades and classes of the professional, scientific and technical staffs of the Civil Service, for the post-war reconstruction of the technical Civil Service, are summarized in a pamphlet recently issued by the Institution (Pp. 4). Broadly, the proposals aim at common salary scales for all professional classes, and a high standard of recruitment and service conditions which will attract to the service of the State the best brains in Great Britain. Within the membership of the Institution there are more than five hundred grades, and the Institution takes the view that the calibre of the officer should be the touchstone in deciding remuneration and that there is no reason why fully qualified scientific workers, engineers, architects, surveyors, etc., should not be paid on common scales. The education of the fully qualified professional man has been such that it produces a man at least equivalent in calibre to the normal entrant to the administrative class, and accordingly the remuneration of the fully qualified technician or scientific man should be on a parity with that of the administrative class. It is proposed that there should be three classes in the Service, each class being normally divided into two grades. Above this basic structure there should be directing posts, the salaries of which would be fixed according to the responsibility of the post. The three classes are designated principal class, executive class, and ancillary class.

Recruitment to the principal class should be from those possessing full professional, scientific or technical qualifications, such as a first or second class honours degree in the relevant science, or membership of the appropriate technical institution. The two grades within this class would be assistant principal and principal, appropriately amplified by fuller titles for different branches of work (for example, assistant principal engineer, principal scientific officer); and the grades should carry parity in remuneration with the assistant principals and principals of the administrative class (at present £275–£625 and £800–£1,100 a year). The members of the executive class would generally work under the direction of members of the principal class and undertake normal technical duties, as well as supervisory duties in workshops and laboratories where full professional qualifications are not required. Recruitment would normally be at the age of eighteen to nineteen years from persons with a good standard of secondary education. The two grades within the class should have parity of remuneration with non-technical executive officers (at present £150–£525) and staff officers and senior staff officers (at present £550–£750). In both these classes the maximum of principal or executive officer should normally be reached well before retiring age.

The third, the ancillary class, would be responsible for routine duties for which it would not be appropriate to employ members of the executive class. It would be roughly comparable with the present clerical class, the standard of education of which is the general schools examination or matriculation. The greatest care should be exercised in the employment of young persons in the ancillary class. Those who show special ability should be afforded an opportunity of acquiring training which would qualify them for entry into the executive class, and this training should not involve undue evening work.

With regard to recruitment, central recruitment should replace recruitment on a purely departmental basis, with a central recruiting board for technical posts under the ægis of the Civil Service Commissioners, and composed of persons with wide experience of professional, scientific and technical staffing requirements. This board's duty would be to certify as eligible for posts in the Civil Service candidates whose qualifications fulfilled agreed standards. It should have the fullest co-operation of the universities and professional institutions, but actual appointments would be made by departmental or regional boards from among those selected by the central board. Since all staff would be recruited by the Civil Service Commissioners, they should be treated on the same basis as the non-technical Civil servants, and come under whatever superannuation scheme is agreed for the Civil Service as from their date of entry into the Service, instead of having to wait several years to qualify for pension rights as have the majority of technical staffs at present.

The reasons for these proposals, which the Institution believes would greatly strengthen the technical service of the State and enable it to play its full part in the post-war reconstruction of Great Britain, are set forth in fuller detail in a second statement prepared on the instructions of the Emergency Executive Committee (Pp. 16. 6*d*.). Some of the recommendations, it is emphasized, are the considered views of that Committee; others are first thoughts, but all are capable of revision in the light of discussion among the membership. A brief report of the Conference on Post-War Reconstruction, held on March 4 and 5, when the draft proposals were considered is included.

Discussing the scope of the recommendations, the statement, recognizing that the professional, scientific and technical branches of the Civil Service need a drastic overhaul, urges that it is essential that this side of the Service should play its part in shaping the post-war Civil Service as a whole, and that the whole Service will be intimately associated with the people in a way which would have seemed impossible before rationing, controls and the inescapable need for central direction of the national economy shattered the aloofness of the servants of the State. As the extent of the contribution of Civil servants to social welfare increases, they must ensure that their tasks are carried out with initiative, flexibility and a full understanding of their implications and repercussions.

In a brief survey of the functions of the professional, scientific and technical staffs, the statement quotes recent evidence that the importance of those functions is becoming more widely recognized, and refers to the approach of the Anderson Committee and the Tomlins Commission to the problem of simplification of the structure of this branch of the Civil Service. It notes that provision must be made for recruitment at higher age-levels to the principal class to obtain the benefit of experience outside the Service, and emphasizes that the duty of the central recruiting board should be limited to certifying the eligibility of candidates for appointment to the Civil Service, selections being made by the departmental or regional boards on the basis of interviews.

A section of the statement deals with the special problems of the immediate future, such as priority

for permanent posts, redundancy, and recruitment at the termination of hostilities. The statement also emphasizes the desirability of the Appointments Department of the Ministry of Labour remaining in being after this transition period and not only registering the qualifications of professional, scientific and technical personnel, but also keeping a register of posts occupied by them, including at least the scale of remuneration of the post. The Institution's support of equal pay for men and women and opposition to the marriage bar is re-affirmed. Consideration of the possibility of the Civil Service Commission adding to its functions in order to become a body for determining salaries is suggested, and an endeavour is proposed to restore the true functions of the Whitley Councils, which include the utilization of the experience of the staff in planning the work of the departments.

## FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

### Monday, December 11

ROYAL ANTHROPOLOGICAL INSTITUTE (joint meeting with the ENGLISH FOLK DANCE AND SONG SOCIETY) (at Cecil Sharp House, 2 Regent's Park Road, London, N.W.1), at 6.30 p.m.—Dr. Ethel John Lindgren: "Shamanism—Some Manifestations in Manchuria".

### Tuesday, December 12

CHADWICK LECTURE (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 2.30 p.m.—Dr. George H. Walker: "Food and its Adulteration during the Present War".*

CHEMICAL ENGINEERING GROUP (joint meeting with the INSTITUTION OF CHEMICAL ENGINEERS) (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. Norman Clarke Jones: "Forestry, and the Utilisation of Waste Wood and its Products as Fuel".

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 5.15 p.m.—Sir Henry Dale, O.M., G.B.E., Pres.R.S.: "Modern Developments in Chemical Therapeutics", (ii) "Recent Advances in Chemotherapy".

### Tuesday, December 12—Wednesday, December 13

AGRICULTURAL EDUCATION ASSOCIATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1).—Yearly Conference.

**Tuesday, December 12**

At 9.30 a.m. (County Education Section)—Mr. F. H. Garner: "The Growing of Field Beans"; Dr. W. A. R. Dillon Weston: "The Fungus Diseases of Field Beans".

At 10 a.m. (Biology Section)—Discussion on "Modern Methods of Pasture Evaluation" (to be opened by Messrs. William Davies and J. Lambert).

At 10.15 a.m. (Analysis of Fodders Sub-Committee)—Discussion on the Report on "The Sampling of Baled Dried Grass for Chemical Analysis".

At 11 a.m. (Dairying Section)—Mr. E. L. Crossley: "Dried Milk Production in War-time".

At 11.15 a.m. (Agriculture Section)—Dr. T. Wallace: "Some Aspects of Mineral Deficiencies in Farm Crops"; Mr. V. C. Fishwick: "The Influence of Nutrition during Early Life on Breeding Capacity and Milk Production".

At 11.15 a.m. (Chemistry Section)—Mr. F. Knowles: "Notes on the Poisoning of Plants by Zinc".

At 2.30 p.m. (First Paper Reading Session)—Dr. C. Crowther: "Agricultural Education and the Work of the A.E.A., 1894–1944"; Mr. James Mackintosh: "Fifty Years of Dairying in Great Britain".

**Wednesday, December 13**

At 10 a.m. (Second Paper Reading Session)—Prof. R. G. White: "The Live Stock Industry in Britain during the last Fifty Years".

### Wednesday, December 13

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 2.30 p.m.—Mr. N. S. Billington: "The Insulation of Buildings—Domestic and Industrial".

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W.1), at 4.30 p.m.—Prof. V. C. Illing: "Exploration".

INSTITUTION OF ELECTRICAL ENGINEERS (TRANSMISSION SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. W. Szwander: "Valuation and Capitalization of Transformer Losses".

BRITISH INSTITUTION OF RADIO ENGINEERS (at the Neville Hall, Westgate Road, Newcastle-upon-Tyne), at 6 p.m.—Dr. T. H. Turney: "Wave Guides".

### Thursday, December 14

GENETICAL SOCIETY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2 p.m.—Mr. D. G. Catcheside: "Nature of Lethals in *Drosophila melanogaster*", 1: "Experimental"; Mr. D. E. Lea: "Nature of Lethals in *Drosophila melanogaster*", 2: "Theoretical"; Dr. G. Pontecorvo: "Genetic Aspects of Heterokaryosis"; Prof. J. B. S. Haldane, F.R.S., and Mr. H. L. K. Whitehouse: "Meiosis in some *Ascomycetes*"; Mr. A. Haddow: "The Artificial Induction of Coat Coloration in Albino Rats"; Mr. P. T. Thomas: "Experiments Imitating Tumour Development"; Mr. U. Philip and Mr. A. Sorsby: "Mutation-rate of Retinoblastoma in Man".

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 2.30 p.m.—Prof. James Gray, F.R.S.: "Locomotory Mechanisms in Vertebrate Animals", (iv) "Relationship of Limb Form to Habit and Environment—Evolution of Types for Climbing and Running".

INSTITUTE OF FUEL (YORKSHIRE SECTION) (at the Chemistry Lecture Theatre, The University, Leeds), at 3 p.m.—Mr. D. W. Milner and Mr. E. Brett Davies: "Coal Tar and its Products as Fuel, and in the Chemical Field".

INSTITUTE OF PETROLEUM (joint meeting with the ROAD AND BUILDING MATERIALS GROUP OF THE SOCIETY OF CHEMICAL INDUSTRY) (at 1 Grosvenor Place, London, S.W.1), at 4 p.m.—Mr. P. Alexander and Mr. J. F. T. Blott: "Factors Influencing the Structural Stability of Sand Carpets".

INSTITUTION OF ELECTRICAL ENGINEERS (INSTALLATIONS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. J. C. B. Nicol: "Organization of Industrial Electrical Maintenance".

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7 p.m.—Dr. G. W. Scott-Blair: "Rheology and the Pharmacist".

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 8 p.m.—Mr. A. Craig Mooney: "Disc Lesions in relation to Pain"; Mr. Hugh Davies: "The Symptomatology and Radiology of Cervical Intervertebral Discs".

### Friday, December 15

SOCIETY OF CHEMICAL INDUSTRY (PLASTICS GROUP) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. R. R. Smith: "Kinetics of Vinyl Polymerisations in the Liquid Phase".

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 5 p.m.—Dr. L. R. G. Treloar: "Rubbers and their Characteristics, Real and Ideal".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. E. J. Heeley: "Some Considerations in the Design of Class 1 Pressure Vessels"; Dr. S. F. Dorey: "A Note on Design Stresses in Class 1 Pressure Vessels".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6 p.m.—Prof. C. E. Inglis, F.R.S.: "The Determination of Critical Speeds, Natural Frequencies and Modes of Vibrations by Means of Basic Functions" (Parsons Memorial Lecture).

### Saturday, December 16

PATHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND (joint meeting with the BIOCHEMICAL SOCIETY) (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 11 a.m.—Discussion on "Cancer".

QUEKETT MICROSCOPICAL SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. W. S. Bristowe: "In Quest of Spiders".

## APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

GRADUATE LECTURER IN BIOLOGY, with qualifications in Anatomy and Physiology, in the Mining and Technical College, Crumlin—The Director of Education, Higher Education Department, County Hall, Newport, Mon. (December 13).

AGRICULTURAL TRAINING OFFICER (administrative)—The Executive Officer, Leicestershire War Agricultural Executive Committee, 7 Friar Lane, Leicester (December 16).

ASSISTANTS (2), one in the MECHANICAL and one in the ELECTRICAL ENGINEERING DEPARTMENT—The Principal and Secretary, Harris Institute, Preston (December 18).

ANALYST by an Engineering Establishment in Lancashire (works experience in the analysis of ferrous and non-ferrous metals and alloys essential)—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.1169.XA) (December 19).

LABORATORY ASSISTANT (Grade I) IN THE DEPARTMENT OF BOTANY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1.

YOUNG ENGINEER OR PHYSICIST with good mathematical qualifications, for development work on Turbines—The Manager, Employment Exchange, Warwick Road, Wallsend.

TECHNICAL ASSISTANT IN THE EDINBURGH ELECTRICITY DEPARTMENT—The Engineer and Manager, 1 Dewar Place, Edinburgh 3.

DIRECTOR of a comprehensive scheme for Recruitment, Training and Education of personnel of all grades in all Coalfields of the country—The Chairman, Mining Association of Great Britain, 53 Parliament Street, London, S.W.1.

LABORATORY ASSISTANT IN THE DEPARTMENT OF BOTANY—The Bursar and Acting Registrar, University College of North Wales, Bangor.

# NATURE

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CONTENTS




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## FUNCTION OF CONTROLS IN INDUSTRY

THE eighth report of the Select Committee on National Expenditure for the session 1943–44 arose out of an inquiry into the chemical controls of the Ministry of Supply, and should remove certain widespread misapprehensions by making plain their functions and responsibilities. Although primarily concerned with the chemical controls, since these are only a part of the organization of the Ministry of Supply for dealing with the chemical industry, the inquiry could not be confined strictly to the activities for which the controllers and their staffs are responsible: In addition to the evidence of the controllers themselves and of the chairman of the Chemical Control Board, evidence was heard from the Ministry of Supply, including the Raw Materials Department and the Director-General of Scientific Research and Development, and the Ministry of Aircraft Production, including the Director-General of Materials Production and the Deputy Director of Research and Development (Technical Investigations). Memoranda were also submitted by trade associations and their firms. The report is accordingly a useful contribution to the present debate on the organization and control of post-war industry.

There are five chemical 'controls', dealing respectively with sulphuric acid, fertilizers, industrial ammonia, molasses and industrial alcohol, and plastics; the control of miscellaneous chemicals has recently been taken over by the headquarters of the Raw Materials Department of the Ministry of Supply. The controls thus form a group within the twenty-nine raw material controls administered by the Ministry, the five controllers constituting a board presided over by a chairman who is responsible for co-ordinating their activities. Describing first the responsibilities and functions of the controls, the report points out that in principle they are executive. The ultimate responsibility for the supply of essential raw materials lies with the Raw Materials Department of the Ministry of Supply; but the controls are the source of information and advice about the complex industries with which that Department has to deal. They thus perform an important advisory function in what may be called the semi-technical field of trade and industry. They are concerned with every kind of action which the Department may be required to take to ensure supplies and their proper distribution and use. In addition to a general supervision of the trade or industry with which it deals, a control may initiate arrangements for the import of supplies from abroad, the provision of new capacity in Great Britain, the distribution of material to the manufacturers or users, and the rationing of supplies to manufacturers and users; and it directs the purposes for which materials may be used and fixes the price of materials.

The importance of utilizing, in the administration of the controls, the knowledge and experience of the trades and industries concerned, has led to the appointment of staff mainly formerly employed in

the relevant businesses, and the report details the over-riding principles which have been laid down to safeguard the public interest in making such appointments. There is no suggestion in the report that these safeguards have not proved adequate; but the report emphasizes that the advisory and information services should be a two-way function; in particular, in referring to the use of existing capacity, the Committee points to the need for giving more adequate explanation to manufacturers whose capacity cannot, for one reason or another, be fully employed. This is a particular illustration of the importance of the advisory committees of manufacturers and others which in some sections of the chemical industry, notably in the fertilizer industry, assist the control to settle both the programme and the way to execute it. So long as the controls remain it is of the utmost importance that they should retain the confidence of the industry, and the existence of an active advisory committee is an excellent means to that end. None the less, in view of the easing of the supply position and the decrease in work, the Committee recommends that the whole organization of the chemical controls should be reviewed and consideration given to the advantages of absorbing them into the headquarters of the Raw Materials Department.

While much of the criticism of the controls is attributed to ignorance of their true position, specific allegations regarding their operation relate to the use of existing capacity, the distribution of new capacity to firms, the allocation of contracts for research and development, and the concentration of production in the paint industry. With regard to the first, the Committee considers that furnishing more adequate explanations and using advisory committees, as already indicated, would have removed its substance. In regard to the second and third points, and particularly the development of methyl methacrylate sheeting or 'Perspex', the Select Committee queries the mode of following the usual policy and giving the whole of the additional capacity for making 'Perspex' to the one original manufacturer. The report suggests that progress might have been more rapid if other firms with the necessary technical facilities had been brought in. A fresh approach to the problems might have resulted in greater progress towards a satisfactory solution.

On the whole, the operation of the chemical controls has tended to strengthen rather than diminish the preponderance of the strongest interests in the chemical industry. This tendency, the Committee recognizes, may be to some extent inevitable in time of war, but in spite of the immense value to the national effort of the resources of the interests in question, there is danger that too much reliance may be placed on the strength of a single concern, making, for example, the control of costs by the Department difficult, since there is no standard of comparison and overheads are difficult to calculate.

Some concern is also expressed by the Committee whether considerable facilities for research and development have been neglected. It is pointed out that even if a firm should not have full confidence in the integrity of the technical officers of the controls, this suspicious attitude should not necessarily prevent the acquisition of the information about its facilities for research and development required before a contract can be allotted. There are Government institutions, such as the Department of Scientific and Industrial Research, the permanent position of which in the service of the State places their impartiality above suspicion, and precedents exist for the use of these bodies where a firm is disinclined to disclose information to the officers of a Department.

The most serious criticism of the report, however, is that of the treatment of the paint industry, and the Select Committee considers that the system of lists adopted was neither economical nor fair. If it was considered that redundant paint-making capacity should be closed, there should have been a proper scheme as provided in the White Paper on concentration of production, with safeguards for the preservation of the commercial existence of closed firms and for compensation. Abandonment forthwith of the lists prepared by the Miscellaneous Chemical Control of paint firms where labour is protected, and to which Government departments confine their direct orders, is recommended.

The report thus affords some justification for the general criticism of the whole system of controls advanced by G. D. N. Worswick in "The Raw Material Controls" (Fabian Tract Series, No. 257. 4*d*.). Mr. Worswick traces the weaknesses of the controls, particularly in planning and lack of foresight, to the staffing of the controls with those already fully conversant with the industry or trade concerned. He argues that the qualities required of a good controller are much the same as those required of a good Minister: intelligence, the ability to grasp quickly the nature of a problem, and the determination to carry out any policy that has been decided. The controller must, of course, have his advisory team of experts, industrial and technical; but what is above all essential in the controller is impartiality and independence of the traditional background of the particular industry and trade. Mr. Worswick argues further that the controls are an essential part of reconstruction, where they should form part of a new branch of government charged with the provision of all the principal industrial raw materials, and the production of substitutes if natural supplies are no longer available. For this purpose three principles are laid down for staffing the controls. First, the head of each control should have no past, present or probable future financial interest whatever in the material he is controlling. Secondly, the use of existing trade organizations as controls should be abolished altogether; and thirdly, the controller should be employed on a terminable contract, say, for five years. To secure the best men, Mr. Worswick suggests that it may be necessary to pay the controllers on the industrial rather than on the Civil Service scale.

In his emphasis on the question of staff and on policy, rather than on the exact nature of the organizational relation of government and industry, and even more on the ownership of industry, Mr. Worswick is

in line with the trend of a subsequent report by a Fabian Research Group "Government and Industry: A Framework for the Future" (Research Series, No. 83. Fabian Society. *6d.*), though he does not lay the same stress on intelligence and information service as the latter report and that of the Select Committee. That function, however, is as vital as the question of staffing and the direction of policy. Unless the Ministry responsible for the controls is well informed, it will not be able either to give guidance on principles of policy which will be commonly applied over the whole field of industry, agriculture and commerce, or indeed to decide on those principles and secure their application.

The review of the war-time controls in this Fabian Research Group report emphasizes that through the controls the Government has gained a far greater knowledge of industry than it had before. This in itself is a valuable asset in devising economic policy, and the reference in the White Paper on Employment Policy to the need for exact quantitative information about current economic movements suggests that the Government is unlikely to throw this away, whatever further means of supplementing it are required. The general supervision by the Government over most of the larger industries established in war-time has proved its value, and has indicated a means by which public policy can make itself felt in the fields of new investment, location of factories, research and development, labour management and labour policy and export policy, independent of the question of private or public ownership. The equity and desirability of such public control has been recognized in numerous statements in the last two years, such as that of Nuffield College on "Employment Policy and Organization of Industry after the War". Recent criticism of the Government has, in fact, centred on the failure of the Board of Trade to give the guidance which industry requires to make its concrete plans for serving the ends of both public and private policy.

The specific proposals of the Fabian pamphlet on "Government and Industry" are simple. A single central authority, specializing in such subjects as cartels, monopolies and restrictive practices, and the location of industry, and building up gradually a body of knowledge and technique, will be an indispensable part of the Government machine. Accordingly, in addition to a permanent buying Ministry to organize the whole of the Government's purchases from, and orders to, industry, there should be a central department for industrial control. This suggested department should be provided with expert sections to supervise all the great industries, whether fully nationalized or not, and should have a series of specialist bodies attached. Thus reinforced, the Board of Trade or Ministry of Industry would act as the final authority on the location of industry, the policy of monopolies and large-scale economic units, management, research and so forth. Again, while trade associations have legitimate functions to perform, they should not be allowed to exercise restrictive powers—a conclusion also reached by the Organization of Industry Committee of the Federation of British Industries in its recent report on the organization of industry in Britain. The Government must therefore have an organization separate from the trade association, through which to control the development of an industry, and to ensure that essential tasks, such as research, standardization, reorganization, export marketing and so forth, are adequately performed.

For this purpose, the Fabian Society's report proposes a series of development boards, not themselves trading bodies, but attached to individual industries and responsible to the section of the Board of Trade concerned with the industry in question. The scheme presupposes a central planning authority in the monetary and financial field, and the report recognizes that a good deal of industrial and managerial skill will be required. The system would make the fullest use of technical men and of business men, its success depending on the extent to which the appropriate administrative ability, impartiality and initiative, rather than technical knowledge, could be recruited. These, as Mr. Worswick stresses, are the ultimate safeguards against bureaucracy and the assurance of positive rather than negative control.

To the Fabian Society's Group, it is true, control still seems to be an end in itself. The committee recognizes the fruitful partnership between the State and industry which we have seen in our war-time arrangements at their best; and the admission that policy and quality of staff rather than sweeping changes in the present ownership of industry are what is required should make possible a broad range of agreement on the methods and objectives of any necessary measure of Government intervention and planning from the centre. The emphasis, however, must be on the minimum of control and on its positiveness in character, as in the Prime Minister's statement in the House of Commons on November 16. It is within these limits that we should seek to discover the principles that should guide and inspire the Government's intervention in industry and decide its policy.

The report of the Select Committee, like that of the Fabian Society's Group, should at least help to get the right questions asked. Few have done more, in fact, than Mr. Herbert Morrison, who contributes a preface to the Fabian report, to clear away prejudices and stimulate constructive thinking on these questions of the relations between industry and the State, and the form which industrial organization must take after the War. None the less, it must be admitted that the idea of restrictionism is embedded as deeply in reports and proposals from the Left, such as the interim report of the Trade Union Congress on post-war reconstruction, as in parallel statements from the industrial side, and it is this idea of restriction, from whichever side, that constitutes the greatest danger to what is commonly implied in a policy of full employment and freedom from want.

The Prime Minister's statement on the continuance of the controls shows that the Government is fully cognizant of what is required, and should reassure

those who, while recognizing the necessity for continuing control, are concerned lest control may be continued for its own sake. Given the principle that control will only be continued where and for so long as the public interest demands, it is possible to evolve out of our war-time and earlier experience the type and kind of control to suit our purposes. These purposes and needs will vary from industry to industry and with the national situation, but there is no reason to doubt the ability of Great Britain to develop a framework of government and industry sufficiently flexible to serve those needs and to foster enterprise and efficiency while securing the essential measure of public control. That involves, as Mr. Morrison and others have indicated, experimenting with different types and degrees of State control over industry, varying from public ownership and operation to a limited degree of control of prices and practices exercised from outside. It involves an intelligence service—or liaison or public relations service, call it what you will—adequate to ensure that the control is always in touch with the local or specialized needs of industries or communities. The joint production committees represent only one aspect of the way in which such public relations work must develop, and no section of a ministry to which the controls are entrusted is likely to be more important than its public relations department. Undoubtedly it will also involve special attention to the questions of recruitment and training of staff.

For all this, the war-time controls can provide only a part of the basic experience required. Beyond such experiment lie the vital factors of policy and of men, as so clearly indicated in the reports mentioned above.

Whatever machinery is devised, there must be the clear enunciation of policy at the centre. The execution of that policy must be entrusted to men who, whether drawn from the Civil Service or from industry, possess the administrative ability and initiative, the imagination and vision, and the impartiality and integrity to ensure that the nation's purposes are fully served.

## BIRDS AND THE CAMERA

### Birds of the Day

By Eric J. Hosking and Cyril W. Newberry. Pp. 128 (78 plates). (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1944.) 12*s*. 6*d*. net.

THERE is a well-known saying that great things arise from small beginnings, and this is true of modern bird photography, which began in those seemingly remote days when a stand camera was the only instrument for all types of photography. There is some dispute as to who took the first wild-life photographs. The names of Riley Fortune, Oliver Lodge and C. J. King, of the Scilly Isles, are among those of the pioneers. They worked with their heads under a black cloth, and their plates were so slow that they could only give a really fast exposure under exceptionally good lighting conditions. Yet they achieved some remarkable results, and when the Kearton brothers perfected the system of working from a hide, nature photography, and in particular the photography of birds, made rapid strides and attained wide popularity.

To-day those who practise bird photography and use their camera to record details of bird behaviour are beyond counting; but none of them has used his camera with better results than Mr. Eric Hosking, whose studies of birds are well known for their interest and beauty. Some of them are snapshots in the fullest sense of the word; for example, a picture in this, his latest book, of a marsh harrier alighting on its nest. The camera has caught it with wings raised in a pose as exquisite as that of a tern; while others are perfect portraits, models of exactness and of accurate rendering of every feather detail.

"Birds of the Day" is the joint work of Mr. Hosking and Mr. Cyril Newberry, the first named being responsible for the pictures of the forty or so species here dealt with, and the latter contributing much field work and descriptive matter. The descriptions vary from short paragraphs in the case of the blackbird and the song thrush to several pages in the case of the marsh harrier and the bittern, perhaps two of the most interesting birds found in Britain to-day. If this is termed a picture book we feel sure the authors will not cavil, for it is obvious the work of the pen is subsidiary to that of the camera.

The subjects are not treated in any special order or sequence, and are limited only to "Birds of the Day". Owls, we understand, are to be dealt with separately later on; however, an example of modern flashlight photography is given in this collection, namely, the portrait of a jackdaw at its nest in an old mill. The introduction of the soundless, odourless flash bulb has placed a most useful tool at the disposal of wild-life photographers. As examples of camera portraiture of birds the two very charming pictures of a male and female bearded tit, the latter with two dragonflies in her beak, perched on the reeds are indeed excellent, even if we long to see the cock depicted in all the beauty of his sandy-red and R.A.F. blue plumage, enhanced by the orange-yellow of his eye and beak, and set off by the black of his moustachial stripes. However, the extended use of colour photography in the ornithological field is coming fast.

For a useful record of bird-behaviour, combined with fine portraiture, the description of the greenshank carrying off hatched egg-shells from the nest and the accompanying illustration are particularly good. The authors tell us that a hiding tent had been in position beside the greenshank's nest for some days, but when the photographer arrived one morning he found the nest empty, only hatched shells remaining; however, he entered the tent and waited results. Before long "the hen greenshank came back, settled over the empty egg-shells, and began to rake them under her. Presently, in response to a soft call from the hen, the chicks came out of hiding in the grass and made their separate ways back to the nest, but the hen was preoccupied with the pieces of eggshell and paid more attention to them than to the chicks . . . she was restless and, after a little while, picked up a piece of shell with her bill and flew away, dropping it in flight . . . gradually all the shell was removed and the chicks came in for their full share of maternal devotion".

Seeing that greenshank chicks leave the nest within a short while of hatching, it is difficult to suggest what purpose, if any, there is in tidying up the nest. It is such observations as these that add value to the work of bird photography. FRANCES PITT.

# THE CHARM OF FLOWERS

## Flowers in Britain

Wild, Ornamental and Economic, and some Relatives in Other Lands. By L. J. F. Brimble. Pp. x+394+18 plates. (London: Macmillan and Co., Ltd., 1944.) 12*s*. 6*d*. net.

ONCE in a while a book appears which impresses the reader from the moment he first handles it. For a long time he has been conscious of a gap in contemporary literature that cries out to be filled; eventually a book appears, and the reader is immediately aware that this is the book for which he has been waiting. "Flowers in Britain" is unquestionably such a book. It was conceived with vision and has been nurtured with the assurance that such a book was badly needed.

Mr. Brimble has prepared it for "anyone who is interested in or wants to know something about flowering plants". These can be broadly divided into two groups. They are the non-botanists, who are interested in flowers for their appearance as much as anything else, and the botanists, who, while equally appreciative of the beauty of flowers, are more concerned with the formal aspects of their study. This book has something to offer to both groups, as well as to the intermediates who could not be classified as belonging to either one or the other.

British people have long had the reputation of being interested in their countryside. We have had striking proof of this during the War by the formation of natural history and field survey clubs in semi-static units of the Armed Forces, both at home and overseas. One such club in the Middle East has achieved considerable prominence, while, in Great Britain, the Royal Society has sponsored a promising movement in the Anti-Aircraft Command called the Nature Observation Scheme. The transfer of town-dwellers to rural areas, as well as the invasion of Great Britain by men from abroad who have made us more aware of the beauty of our own surroundings, has also served to deepen the regard for wild life. (Not many years ago, M. Herriot, the distinguished French statesman, was a guest in Oxford. He was asked by H. A. L. Fisher what had struck him most on this his first visit to England. "Two things," he replied, "first your rabbits and second your flowers.") Some of these people have particular interest in flowering plants, and to them this book would be a rich store of delight.

What has Mr. Brimble to offer here to the botanist? In the preface he writes: "One frequently finds that academic botanists, though thoroughly well-versed in the classification, structure, function, and so forth of the British native flora, are unfamiliar with garden flowers, many of which are really exotics. It is sometimes a matter of wonder to a non-botanist that many academic botanists, even those who have taken a university degree in the subject, know much less about the flowers of our gardens than the ordinary gardener". There is little need to labour his point, and many botanists will be grateful for the section on ornamental plants which appears under each family.

The order of the book can be briefly stated. There is a short introduction on the structure and classification of flowering plants, and then a series of chapters on the natural families, arranged, more or less, in evolutionary sequence. Each family is treated under the headings of plants indigenous to Great Britain, ornamental plants, and economic plants. The text is reinforced by more than thirty line drawings—all of them prepared by the author—and 160 photographs, and 18 coloured plates. The plates were painted by eminent floral artists; they are a tribute to their calling and to that of the printers who have prepared the plates for this work. Finally, the author has not forgotten the time-honoured part played by flowers in literature, and the book abounds with quotations as apt as they are entrancing.

In reading this well-merited praise, however, it must not be imagined that the book is without fault. Presumably, in trying to make the matter as clear as possible for the non-professional, Mr. Brimble has, on several occasions, fallen into the habit of 'writing down' to his reader. This has resulted in the production of some loose and grammatically unacceptable phrasing which might have been eliminated by severer proof-checking. There are a few factual errors, while, in some cases, the author has attributed to plants purpose and design. Further, some of the black-and-white photographs are not sufficiently clearly printed to illustrate the point under consideration.

Yet the standard of the book makes these criticisms seem almost churlish or carping. It is a magnificent production which should add considerably to the author's growing reputation as a writer of general biological works. When the next edition is printed, it is to be hoped that the supply position will have so much improved that the paper on which the text is printed becomes worthy of the matter.

T. H. HAWKINS.

# FOOD SCIENCE

## The Chemistry and Technology of Food and Food Products

Prepared by a Group of Specialists under the editorship of Dr. Morris B. Jacobs. Vol. 1. Pp. xvi+952. (New York: Interscience Publishers, Inc., 1944.) 10.50 dollars.

DR. MORRIS B. JACOBS, with the aid of forty-one expert collaborators, has set out to write a text-book in two volumes covering the whole field of food science and technology—a difficult if not an impossible task. Volume 1 is in two parts and contains 900 pages of subject-matter. Part 1 occupies 390 pages and is concerned with fundamentals—the physical chemistry of foods, the carbohydrates, lipoids, amino-acids and proteins, enzymes, vitamins and minerals, colouring matters, food spoilage and poisoning. All the sections are well written and largely up to date, and no doubt there are few research workers who would not profit by reading them. At the same time, many will feel that it is rather an unnecessarily heavy and rich hors-d'œuvre for the massive courses that follow.

Part 2, on foods, covers milk and dairy products, meats, fish, poultry and eggs, edible oils and fats, cereals, baking, fruits and vegetables, carbohydrates, confectionery and cocoa products, flavours, spices and condiments, coffee and tea. Each of these commodities is treated by an expert in the particular field, some of them of international renown. At the same time they are all very busy people, and one cannot help feeling that they would have written even better articles after the War when the demands on their time will be reduced.

In evaluating Volume 1 it is essential to remember

what Volume 2 will contain. We are told that it will be in four parts dealing with unit-operations and processes, sanitary and quality control, methods of preparation and methods of production. Dr. Jacobs, in his preface to Volume 1, points out that a certain amount of overlapping of the subject-matter is inevitable. Some of this could have been avoided; it is irritating, for example, to find canning and gas storage dealt with to the extent of about 200 words each, when presumably they will be considered in detail somewhere in Volume 2. For the same reason, it is difficult to criticize Volume 1 from, say, the points of view of omissions or meagreness in detail, not knowing what the next volume will contain.

The general level of the sections on foods in the volume under review is, as would be expected, excellent. The treatment of dairy products is obviously relatively meagre; but this is subject to the qualification in the preceding paragraph. The section on meat products deals sparingly with the changes in rigor mortis but compensates for this by a succinct and excellent statement on muscle pigments. Some readers will detect a touch of the quixotic in the statement that the 'drip' from frozen meat is dependent upon the duration of storage but is apparently unaffected by the temperature of storage. Others will be eager to know more about the asphalt treatment of hams and bacon. Dr. Mary Pennington discusses poultry and eggs with authority and experience, and will intrigue the reader with her reference to the fact that wax picking of poultry—the removal of feathers simply by dipping the birds in melted wax and stripping off the solidified wax—has now been supplemented by a "rubber finger picking machine" which removes most of the body feathers before the wax treatment. The sections on cereals and baking are outstanding. Prof. Geddes, however, does not mention the considerable difference in the riboflavin values found for cereal products in the United States and Great Britain; also his calculation that 12–15 per cent of germ is required to raise the vitamin $B_1$ level of patent flour to whole-wheat level applies only to the embryo fraction of the germ and ignores the two years old work in Britain which revealed the high content of vitamin $B_1$ in the scutellum fraction of the germ.

Two general criticisms can be levelled at the book. In the first place, it is disturbing that so many references are made to other published *books* and not to original papers. This fact not only tends to reduce the value of the book to the research worker but also raises doubt that a piece of original research is dealt with correctly and adequately. A further outstanding point is that the bulk of the references—perhaps more than 90 per cent—refer to American and Canadian work. It is hard to believe that the published work of the Food Investigation Board, the dairy research institutes, the food research associations and commercial laboratories in Great Britain merits less than 10 per cent of the references. There must be an explanation. Possibly it would help if we had one or two recognized journals for the publication of papers dealing directly with investigations in food technology—comparable with, say, *Food Research* or *Cereal Chemistry*. Whatever the solution, it is a challenging problem.

It is easy to criticize, and, having said that, let it also be acknowledged that this is probably the best book that has yet been written on food science and technology.

T. MORAN.

# THE ADVANCE OF BIOCHEMISTRY

## Annual Review of Biochemistry

James Murray Luck, Editor; James H. C. Smith, Associate Editor. Vol. 13. Pp. ix+795. (Stanford University P.O., Calif.: Annual Reviews, Inc., 1944.) 5 dollars.

IN his story of his visit to India, which has so arrested the attention of all of us, Prof. A. V. Hill has emphasized the need for biological research in particular in order to solve the many complex Indian problems.

The "Annual Review" may serve as an indication of the extent to which chemistry is allied with biology in the urge to extend knowledge. The findings are being far more rapidly applied to public welfare than of yore—in medicine, in food, in hygiene and in agriculture. If it be accepted that chemistry is the basic science, which has discovered how things are composed, what properties they have and how they will react, while physics provides an explanation of the rules of the chemical game, then the chemist must pioneer in the study of substances of physiological importance. He must know their structure, their properties and be able to explain the very complex reactions in which they take part. His difficulty has been, and is, to obtain them in sufficient quantity or of satisfactory purity for his purely chemical studies, so that real progress has had to wait on advances in laboratory technique as, for example, microchemical analysis, separation by selective adsorption.

The past decade has been fruitful in such methods, and progress has been the more rapid in consequence. It must be realized that a high standard of manipulative skill is required from the biochemist; further, that he is responsible for the soundness of his work, so that hasty publication is to be deplored.

In fact, the yearly output of biochemical papers is so great that no one can master even a tithe of them, nor indeed would his time be profitably employed. Hence the ever-increasing value of the "Annual Review of Biochemistry", now issued for the thirteenth time by Messrs. Luck and Smith, to whom all workers owe a very profound expression of thanks. For us in Britain it is the sixth winter of war and no such publication of eight hundred well-printed pages would be possible: our American cousins are more fortunate in escaping, or perhaps overcoming, the usual difficulties attendant upon the War, but our envy takes a very mild form, for we share on equal terms their gift to biochemists and are indeed grateful.

The 1944 volume takes its usual form, the subject being broken up into twenty-six sections, some of which are the joint responsibility of two authors. The standard throughout is high; the articles as a whole are more readable and less a catalogue of specialist progress.

The complex carbohydrates do not lose their attraction and are the subject of an admirable review by W. Z. Hassid. Those who listened to Prof. W. N. Haworth's very lucid Bakerian Lecture before the Royal Society know how apparently simple this complex subject can be made to appear; Dr. Hassid is almost as successful. One leaves the article wondering why Nature had to be so involved in creating such complexity from simple starting materials.

The proteins and amino-acids are no less important to-day, and their study, particularly that of the structure of the intact protein molecule, is returning

to fashion. Attention is perhaps focused on the preparation of proteins possessing unique and specific biological properties, that is, enzymes, hormones, viruses and immune bodies. Phosphorus compounds receive a special section commensurate with the increasing recognition of the part they play in reactions *in vivo*. Last year, sapogenins and saponins were reviewed under the heading of steroids; this year's story is limited to recent work on bile acids, sterols and steroid hormones. These are most complex substances; they play an important and universal part in living tissues.

Metabolism is broken up into many sections. The painstaking accumulation of facts and their verification is step by step contributing to progress—the significance of what are called trace elements in mineral metabolism is becoming more and more clear. Apparently the land animal of to-day has not entirely forgotten that it was once in bygone ages a marine organism.

The subjects of hormones and vitamins attract as much interest as ever, though the number of references quoted is not so large. Great interest is attached to the reports on nutrition and on nutritional deficiencies in farm animals. The War has both focused attention on such questions and given added stimulus to their study.

There is a well-written section on alkaloids by R. H. F. Manske : there seems to be no end to these compounds, and it is to be hoped that before long their inter-relationships and meaning will become clear. Even more interesting is the chapter by F. F. Blicke on synthetic drugs. The spectacular progress of chemotherapy has attracted the attention of the public at large, who are benefiting to-day from the drugs very soon after their discovery. Naturally fungi also require a section, written by E. L. Tatum. The discovery of penicillin has raised popular hopes that other moulds may contain a host of other specifics; but this article is severely scientific and more interested in a tentative interpretation of the biogenetic relationships of the mould products. All must ultimately have come from sugar and they represent end-products of carbohydrate metabolism; they belong to a rather limited number of chemical groups.

Only a very cursory survey of some of the reviews has been attempted, with the object of showing how much there is in the volume, which even at the risk of repeating what has been said in other years is once more certainly indispensable.

E. F. ARMSTRONG.

## PHYSICS AND PHILOSOPHY

### Physics of the 20th Century

By Pascual Jordan. Translated by Eleanor Oshry. Pp. xii+185. (New York: Philosophical Library, Inc., 1944.) 4 dollars.

THE story of the rise and development of twentieth century physics has been told so often and by so many 'leading world authorities', that, fascinating as it is, one's first reaction to any further author who proposes to guide the footsteps of the 'layman' along the now well-worn and familiar track is to ask (perhaps a little ungraciously): "Is your journey *really* necessary? Have you some points of view of interest to disclose which your predecessors have missed, or some matters of moment to discuss which others have, perhaps, insufficiently considered?" It may be said at once that, in the case of Dr. Jordan, the answer is definitely in the affirmative. While some authors have dealt more fully, and perhaps more clearly, with the experimental discoveries upon which the concepts of the new physics are based, and others have expatiated on the impact of these discoveries on industry, commerce and the social order, to Dr. Jordan the main interest of the story is in its intellectual content; to him it is primarily a spiritual adventure. "Our most wonderful moments of scientific evolution," he writes in his preface, "are experienced when it is shown that we must revise our ideas from the ground up to agree with a new concept. Modern physics effected many such changes; and in the most fundamental respects. That is what this book would like to tell about."

The 'layman' to whom Dr. Jordan addresses himself is thus not so much the scientist *manqué* as the philosopher, whether amateur or professional, who may wish to consider what bearing, if any, the new concepts of twentieth century physics may have on his own particular interests. It is true that philosophers have not so far shown quite as much interest in modern physics as some modern physicists have shown towards philosophy, and it may be readily admitted (as, in fact, the author does admit) that neither the methods nor the ultimate objectives of philosophy are those of physics. It is equally true, however, that even the most abstract philosopher can scarcely escape the intellectual atmosphere of the times in which he lives. There can be no doubt, for example, that the rise of dialectic materialism was largely aided and abetted by the existence of the 'mechanistic' school of physicists, who imagined (quite erroneously as it appears to us to-day) that, given the co-ordinates and momenta of all the atoms in the universe, it would be possible for a competent college of mathematicians to calculate all past and future history. The gradual abandonment by physics of the 'mechanistic' point of view, and the reasons which made this change of viewpoint inevitable, form the subject-matter of the present volume.

As far as may be, the author has endeavoured to present an unbiased and objective account both of the progress and the conclusions of modern physics, and has confined himself to indicating the particular points at which they appear to impact upon the conclusions of philosophy and theology. While it is, of course, well known that Dr. Jordan has his own ideas on the subject, he does not, in the present volume, intrude them upon the reader; or commit the tactical error of putting up the back of the philosopher by attempting to do his work for him.

It is unfortunate that the effect of the book in its English dress (it is a translation) should be marred by a rather involved style, and some infelicities and even obscurities in diction. How far this is due to the original manuscript, one cannot say; but only too often the translator appears to have been satisfied to transliterate the author rather than to try to present his ideas in current English; so that the unfortunate reader is left to wrestle simultaneously with unfamiliar ideas and a foreign idiom. The book, however, is one of real distinction; and readers interested in the fundamental problems and ideas of which it treats will be well advised to make the effort. Its appearance at the present time serves as a useful reminder that twentieth century physics is not solely, or even mainly, concerned with the gratification of the national animosities or material desires of mankind: it has a specific contribution to make to the ocean of universal learning.

# MOUNTAINS THAT HAVE TRAVELLED OVER VOLCANOES*

By DR. E. B. BAILEY, F.R.S.
Geological Survey of Great Britain

## Contrasts of Facies of Contemporaneous Formations in the Alps

GEOLOGICAL formations may vary greatly in character, or facies, from place to place. In the Swiss Alps the Mesozoic sediments show several facies associations, sufficiently definite to be given names. Of these the most commonly encountered is called Helvetian, while another of more restricted occurrence is called the Klippe facies. The name Klippe is taken from the German word for a cliff, because this particular facies is well displayed in some cliff-bounded mountains which form a conspicuous scenic element in the neighbourhood of Lake Lucerne. Equivalent formations exhibiting the Helvetian and Klippe facies are often so completely different in appearance that no one would guess their contemporaneity were it not for their contained fossils. This is truly amazing because the two facies in many localities lie cheek by jowl.

Bernhard Studer did more than anyone else to gather the facts. He found so early as 1834 that the Klippe facies was represented by the rocks of a considerable continuous mountainous area, later christened the Préalpes romandes, which reaches from near Geneva north-eastwards to Lake Thun; and also that it reappears in a surprisingly big proportion of boulders and pebbles contained in Early and Mid Kainozoic sediments along the northern face of the Alps. He deduced therefrom, quite correctly, that the Prealps represent the remains of a northern marginal chain which was being subjected to erosion in Early Kainozoic times. He further assumed, as a matter of course, that this chain had risen from below in the district where its remnants are still recognizable; and that its frequent non-appearance at the surface depends upon burial, partly beneath its own accumulated debris and partly under folds of Helvetian facies that have travelled a little distance from the south. Studer's conception failed to account for the abrupt change of facies, met, for example, on crossing the margin of the Prealps. It also contradicted every field observation of the structural relationships of Klippe and Helvetian complexes, for universally the Klippe complexes present the appearance of resting on top, not rising from below (Fig. 1). Still, it was the only interpretation that could be offered without invoking large-scale over-thrusting, and for this reason it remained all but unchallenged for fifty-nine long years.

In 1893 enlightenment came to Hans Schardt, who for the past fourteen years had been groping in the semi-darkness of the times trying to solve some of the riddles presented by the Prealps. Suddenly, he found himself standing in a flood of light which illuminated, not only the present position of the chain, but also the history of its development. There before him stretched the Prealps, a complex of Mesozoic and Kainozoic formations, entirely underlain by the local Kainozoic; an immigrant countryside fashioned of alien rocks that bespeak a southern origin; an erratic, as truly as any of the great blocks of Mont Blanc granite which we find jettisoned by vanished glaciers upon the flanks of the Juras—but an erratic, 75 miles long and 25 miles broad!

The Prealps are a composite erratic formed of a succession of superimposed thrust-masses. The higher thrust-masses have travelled farther from home than the lower, and each in turn has brought with it a distinctive stratigraphical facies. It was indeed the realization of the existence of multiple facies contrasts that cleared the way to understanding. Schardt had been brought up on Studer's two facies, Helvetian and Klippe, exposed side by side. The phenomenon was far too familiar to worry him as it really ought to have done. It therefore came as a mental shock and much-needed tonic to learn that Maurice Lugeon, through a find of fossils, had demonstrated another, and even more striking, facies contrast in the self-same area. Schardt realized at last that a far-travelled thrust-mass may often be recognized by the foreign characteristics of its rocks, just as a far-travelled man may often be recognized by the colour of his skin or the words of his speech. Bertrand, Suess and a few others had already looked

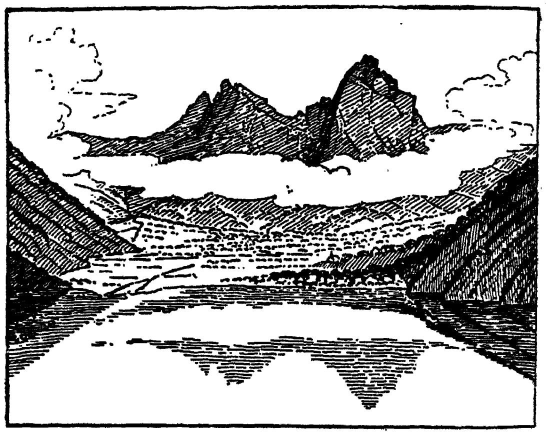

Fig. 1. THE MYTHEN FROM LAKE LUCERNE (AFTER ALBERT HEIM). This Klippe consists of Mesozoic rocks of Klippe facies. Heim has drawn a symbolic cloud to represent obscurities of pre-1893 interpretations. The grass below the cloud is on Kainozoic; from below on either hand emerge Mesozoic crags. All below the cloud is of Helvetian facies.

for help in this direction; but the regular employment of facies as a tool in the disentanglement of mountain structure was introduced by Schardt's appreciation of its value in relation to the Prealps.

The controversial spirit that was aroused by Schardt's "Origine des Prealpes romandes"[1] was reminiscent of that stirred by Darwin's "Origin of Species"; but opposition soon gave place to co-operation, and the new opportunities opened up for research led to a sustained, brilliant and most fruitful attack, altogether without parallel in the history of geology, upon Alpine problems.

Before leaving Schardt and his Prealps let us note that his re-interpretation of Studer's Klippe-facies marginal chain, as a superstructure riding upon adjacent Kainozoics, enabled him to account for its manifest gaps by invoking erosion, pure and simple. Studer, it will be remembered, had had to supplement erosion with burial. Moreover, the Klippe-facies pebbles enclosed in the over-ridden Kainozoics justified Schardt in claiming that the postulated erosion actually started long before the thrust mountains had ceased to travel over the floor of the sea which then lay to the north of them.

* Extract from a Friday discourse delivered at the Royal Institution on November 3.

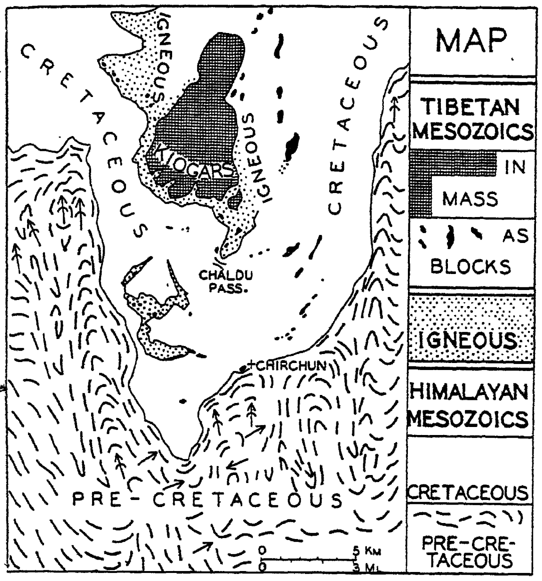


Fig. 2. BASED ON ARNOLD HEIM AND A. GANSSER.

## Facies Contrast in India

From Alps to Himalayas is a comparatively easy journey for a geologist. Both chains form part of one continuous Kainozoic range that stretches from Spain to the Dutch Indies; and both are in large measure fashioned of uplifted marine sediments that accumulated in an ancestral Mediterranean Sea called by Suess the Tethys. These sediments are particularly well displayed in the north-western Himalayas, where they form a mountainous belt 500 miles long, lying north-east of, and parallel to, the main line of giant snow-clad summits. The Spiti Shales of Mid Mesozoic age are their best-known component formation. For many centuries beautifully preserved fossil ammonites from these shales have been sold as sacred relics in the holy places of India. Thus we find that long before any geologist had seen these fossils *in situ*, examples had been described and figured as type specimens of new species and genera.

We are here concerned almost wholly with the south-eastern part of the belt, where it forms the divide between the Upper Sutlej and the head waters of the Ganges, at the same time serving as mutual frontier to Tibet and India. Here in the Kiogar-Chirchun district, C. L. Griesbach, C. Diener and C. S. Middlemiss in 1892 made a momentous discovery[2]. They found two markedly distinct facies of Mesozoic and Upper Palæozoic sediments in close juxtaposition (Figs. 2, 3). The first of these is now styled the Himalayan facies. It is characteristic of the 500-mile-long belt as a whole and differs notably from that of any time-equivalent known in Europe. The second, as yet only recognized in the Kiogar-Chirchun district and its continuation to the east, is spoken of as the Tibetan facies. On certain horizons it is almost identical with a locally developed facies found in the Austrian and Bavarian Alps at Hallstat, Hallein and (tell it not at peace conferences) Berchtesgaden[3,4].

Griesbach and Diener were Austrian in origin, as also was A. von Krafft, who later visited Kiogar and whose 1902 description furnishes the main foundation of our present knowledge of the district. Griesbach was for long a member of the Geological Survey of India, rising eventually to be its director. Diener was a professor at Vienna, who described many fossils collected by the Survey besides those he himself secured during the 1892 Expedition; von Krafft, like Griesbach, was on the staff of the Survey, but only for a short period. He died in 1901 before the appearance of his wonderful memoir to which reference has just been made.

In the Kiogar region the sediments of Tibetan facies are usually found as extensive masses or isolated blocks, partly overlying, partly involved in, a thick complex layer of igneous rocks; while the sediments of Himalayan facies usually underlie this igneous layer and are arranged among themselves, broadly speaking, in normal succession. Obviously, to reach their present extraordinary situation the Tibetan sediments must have travelled considerably. Still Griesbach and Diener, though well aware as time went on of current discussion of facies contrasts presented by Klippes in the Carpathians and the Alps, never admitted that the Tibetan masses of Kiogar had travelled horizontally through any significant distance. They thought it enough to imagine that the Tibetan assemblage had been pushed up in some unusual fashion to furnish a fault-breccia, and they regarded its facies peculiarities as a mystery totally unconnected with its anomalous structural position[5-8]. On the other hand von Krafft, Suess and later participants have clearly recognized that the facies contrasts between the overlying Tibetan and underlying Himalayan successions denotes great horizontal travel of one in relation to the other. Von Krafft attributed this travel to volcanic activity, operating either through the force of explosions or through the floating agency of lava streams (ref. 3, pp. 170, 173); but Suess[9] and his successors have attributed it to over-thrusting of the same type as is manifested

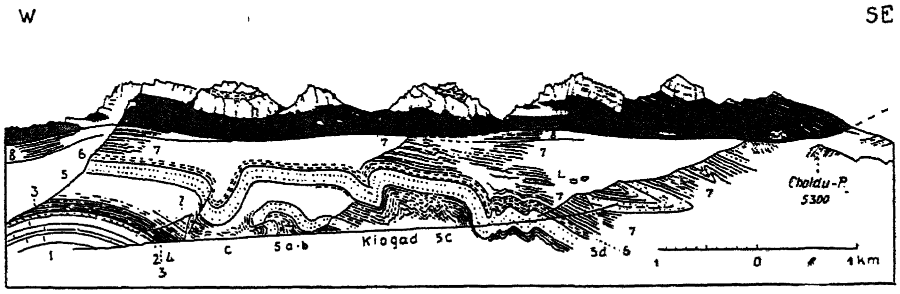


Fig. 3. KIOGARS (AFTER ARNOLD HEIM AND A. GANSSER).
Summits: Tibetan Mesozoic sediments, mainly Pre-Cretaceous.
Intervening: Igneous complex (shaded).
Lower slopes: Himalayan Mesozoic sediments: 1–4, Pre-Cretaceous; 5–8, Cretaceous, with radiolarian chert constituting 8.

in so many other mountain chains. Naturally the advocates of over-thrusting have sought to provide room in their theories for the emplacement of the igneous complex that separates the Tibetan and Himalayan sediments. In this direction there has developed considerable diversity of opinion.

## Igneous Rocks of Kiogar

Before discussing any of the rival Kiogar theories, it will be as well to enter into a little more detail regarding some of the rocks of the district. In doing so I shall avail myself in the main of von Krafft's observations, but shall accept certain important modifications recently introduced by Arnold Heim and August Gansser. The former, son of the distinguished geologist, Albert Heim, was brought up to geology from the cradle. His very name, Arnold, at once recalls his father's reverence for the great pioneer, Arnold Escher von der Linth. In 1935 Heim junior visited me in Glasgow, and I had the great pleasure of hearing of his preparations for an expedition to the Himalayas. In return I told him how I had been led to modify in an important detail Suess's interpretation of the Kiogar district, and I urged him to include this wonderful locality in his itinerary. Next summer, while I was assisting in the celebration of Harvard's tercentenary by propounding my story of mountains that have travelled over volcanoes[10], Heim and Gansser were hammering new facts out of these same mountains, to the great advantage of our science.

The topmost Tethys sediments of Himalayan facies in the Kiogar district belong to the Cretaceous System at the summit of the Mesozoic Group. The Lower Cretaceous is represented by some 2,000 ft. of greenish, glauconitic sandstone. Specimens from the Kiogar district, and also farther east, contain small fragments, which under the microscope are seen to correspond in type with lava-like constituents of the igneous complex lying at higher levels[11]. The Upper Cretaceous consists mainly of shales, for the first 2,000 ft., followed upwards by radiolarian cherts, amounting to another 1,000 ft. (von Krafft gives much smaller measurements).

I speak of these cherts as Upper Cretaceous, since such is the custom; but an early observation of Griesbach's near Dangpu, not far from the Sutlej, suggests that they may extend into the early Kainozoic[12]. Another interesting point to recall is that Griesbach, on first meeting with the associated igneous rocks, immediately and, as is generally agreed, correctly correlated them in a general way with other igneous occurrences already recorded by Strachey in 1851 at the Manasarowa Lakes and, much farther away, by F. Stoliczka in 1865 along the course of the Upper Indus. Though a general age correlation between the Upper Indus, Kiogar and Manasarowa rocks seems certain, I do not think there is a close structural connexion between the outcrops of the Upper Indus[13] on one hand and those of Kiogar and Manasarowa on the other. It looks rather as if research should be directed to establish a structural connexion between the Upper Indus belt and one that has recently been sampled by Gansser at Kailas (ref. 11, p. 187). The Upper Indus belt has been extended westwards to the Burzil Pass by D. N. Wadia[14]. *I confess that I have in previous publications employed Wadia's finds of fossils at Burzil on the misunderstanding that they came from the same structural position as is represented at Kiogar.* Fortunately there remains other evidence, which I could have put forward at the time, to demonstrate submarine volcanic activity at Kiogar, and this I develop below. The only known occurrence of igneous rock, which seems to occupy the Kiogar position in the Indus area, is a volcanic outlier in Zanskar, fifty miles west of Leh[15].

The radiolarian cherts constitute a new discovery due to Heim and Gansser. Of course 1,000 ft. of sediments cannot escape notice, but Griesbach in 1891 could only speak of what he saw as "a singular rock", while von Krafft later mistook it for "very thin-bedded tuff", that is, compacted volcanic ash.

In my 1936 approach to the Kiogar problem I had given a somewhat full account of Steinmann's great generalization regarding the oft-repeated world-wide association of radiolarian chert, serpentine and pillow lavas* (ref. 10, pp. 1718–1722). Accordingly, when Heim and Gansser announced their discovery at Kiogar they wrote: "Professor Bailey's ideas have proved to be of considerable bearing and he will be amazed that we have found indeed in great extension the radiolarites he probably has thought of, in conjunction with the igneous greenstones" (ref. 11, p. 146). To which I replied "Amazed ? Surely not ! Only sorry that Steinmann did not live to hear the welcome news"[16]. Though far from amazed, I was naturally delighted. Heim and Gansser's great find had completed the expected trinity. Serpentine had long been recognized and described in the igneous complex of the Kiogar region by von Krafft, who had submitted his material for microscopic examination to his colleague Thomas Holland (ref. 3, p. 136). It is also known in great bulk, associated with wide stretches of undecomposed peridotite, to the north of the Kiogar heights and near the Manasarowa Lakes (Heim and Gansser, ref. 11, pp. 183 and 179). Pillow lavas, too, had been described by von Krafft at Kiogar, though lack of experience prevented him from recognizing their true nature. In his account von Krafft quotes from Holland's descriptions such remarks as : "most of the rocks present the characters of lava flows, generally basic in composition, but much too altered for precise determination", and "many are distinctly amygdaloidal". He then turns to field aspects of the igneous complex and tells, for example, how he has met on the screes "round balls of amydaloidal andesite, approximately 2 ft. in diameter", which "on being broken up were found to contain calcite kernels, large in the centre, and decreasing in size towards the periphery". "In two places I observed," he added, "a spheroidal or sack-like structure in solid lavas, no doubt the result of weathering" (ref. 3, p. 137, also pp. 159, 165). It will be noticed that von Krafft attributed the ball or sack (that is, pillow) structure to the familiar phenomenon known as spheroidal weathering. This suggestion is negatived by two considerations :

(1) Rocks in the decomposed condition recorded in Holland's, and later, descriptions do not develop spheroidal weathering[17] ;

(2) Spheroidal weathering does not lead to development of central cavities such as are represented by the "calcite kernels" mentioned above.

On the other hand, von Krafft's description irresistibly recalls many familiar occurrences of pillow lava. The nearest analogue that I know is a pillow lava in Cornwall. In individual pillows, C. Reid and H. Dewey have said, "the amygdules are smallest in the outermost layers, and decrease in number but

* Steinmann did not admit that what we others call pillow lavas are really extrusive; but this mistake of detail is dealt with sufficiently in my 1936 paper.

increase in size towards the interior. The centre is often highly vesicular, with a large cavity from which the infilling calcite has been weathered out"[18].

Naturally when Heim and Gansser's descriptions appeared I looked to see if they had anything to say of the two exposures in which von Krafft had noticed spheroidal lavas. One not far from the summit, Kiogar 5, is figured and described as follows: "Red chert with radiolarians and associated, more or less siliceous limestones and marls" with "flags occur in such abundance" in the igneous mass "that they form a kind of stratification" (ref. 11, p. 156; the locality corresponds with von Krafft's in ref. 3, p. 159).

The inference I draw from the above facts seems to me secure: volcanic activity started in the Tethys somewhere near Kiogar early in Cretaceous times, and provided a little ashy material to the Lower Cretaceous sandstone; later, following an important development of radiolarian cherts, the local Tethys volcanoes became much more active and poured out submarine lavas, some of which assumed pillow structure; radiolarian chert continued to be deposited during quiet intervals; serpentines were intruded.

The same general assemblage of igneous rocks as presents volcanic relations to the underlying Himalayan sediments presents intrusive relations to the overlying Tibetan sediments. It is not only the coarse-grained serpentines that behave intrusively, but also the fine-grained lava-like rocks. In many cases these latter traverse the Tibetan sediments as narrow veins. In others they enclose entire blocks. The veining affects all members of the Tibetan succession, including certain occurrences which Heim and Gansser refer to the Cretaceous period (ref. 11, p. 162).

## Rival Theories

(1) We have already noted von Krafft's theory of volcanic transport of the Kiogar masses of Tibetan facies. He supports it by reciting many described examples of sedimentary material enclosed in volcanic ashes in other parts of the world; but he frankly admits that he has found no record of anything approaching the Kiogar scale (ref. 3, pp. 170, 173). Von Krafft's own descriptions and illustrations emphasize this difficulty of scale so clearly that as yet no one seems to have accepted his interpretation. Heim and Gansser, who have examined the ground, report that "the Kiogar limestone extends over many square kilometers, and permits to recognize its stratification over considerable distances", and also "the Kiogars are the remains of a thrust sheet coming from the Tibetan side, as already supposed in spite of v. Krafft's contradictory conclusions by E. Suess, F. Kossmat and E. B. Bailey" (ref. 11, pp. 160, 161).

(2) Suess, as just mentioned, interpreted in 1904 the Kiogar sediments of Tibetan facies as remnants of a far-travelled thrust-mass. He further interpreted the igneous complex that intervenes between the postulated thrust-mass and its Himalayan foundation as having been injected in this position during the forward progress of the thrust-mass.

(3) I was attracted to von Krafft's memoir by Suess, as presented in de Margeries' edition, "La face de la terre"[19], enriched with illustrations not to be found in the original of "Das Antlitz der Erde". I felt that Suess was in the main correct, but that he had overlooked an important aspect of the igneous complex, namely, that it includes representatives of submarine lavas as well as of subterranean intrusions. "I take it," I wrote in 1936, "that a Tibetan nappe has passed over a line of active submarine volcanoes; and that thereafter, for a while, magma has flowed along the thrust at the base of the nappe; but whether or not the original volcanoes were fed from a thrust plane has not been decided" (ref. 10, p. 1723). The above exactly expresses my present position after studying the host of new facts brought to light by the researches of Heim and Gansser. I consider that the Kiogar region furnishes the most remarkable geological monument in the world. It shows a Tibetan thrust-mass, which in its advance closed the mouths of Himalayan submarine volcanoes, and got itself riddled with multiple injections as a natural consequence. It combines the phenomenon of far-travelled facies, which Schardt illuminated in his 1893 interpretation of the Prealps, with that of tectonic smothering of vulcanicity, a conception sufficiently thought-provoking in itself.

(4) Heim and Gansser have advanced another variety of the volcano plus thrust theory. They consider that lavas and intrusions developed in late Cretaceous or early Kainozoic* times "in a remote Tibetan zone on the south side of the Trans-himalaya at the bottom of the deep sea and below it. Blocks slipped down from the coast and were embedded in the igneous flows. Then followed the thrusting towards the south" (ref. 11, p. 163). I do not think that the authors are likely to retain this "preliminary view", as they call it, because it is scarcely in accord with all the evidence they themselves have marshalled. They have been led to interpret the volcanic rocks, and many of the intrusions, as part of the far-travelled Tibetan thrust-mass, because they have found the igneous rocks in certain cases obviously affected by movement; and yet they are satisfied that the serpentines, though also obviously affected by movement, are quite certainly intruded into the Himalayan Cretaceous (ref. 11, pp. 184, 185). Similarly, in dissociating the volcanic rocks from the Himalayan suite and attaching them to the Tibetan suite, Heim and Gansser seem to forget that they have found debris of similar rock types in the Himalayan Lower Cretaceous sandstone. Moreover, they are driven to interpreting the radiolarian cherts between the lavas as Tibetan in contrast with the radiolarian cherts below the lavas, which latter they class as Himalayan. Regarding the cherts between the lavas they say: "The igneous flows must have been in relation to the deposition of the youngest sediments of the region which are regarded as Upper Cretaceous deep sea deposits. In the south-eastern Kiogars both are even mixed in a way as if the flow had penetrated and imbibed the flysch series [cherts in this case] chiefly along the bedding planes as it could hardly have been the case at the subaerial surface" (ref. 11, p. 162). I could name various other difficulties if space permitted.

## Exotic Blocks of the Kiogar-Chirchun District

In sketching the conditions prevailing in the Kiogar region, I have up to now avoided reference to the fact that many blocks of Tibetan sediment, together with associated igneous material, occur embedded in the Himalayan Cretaceous shales. The phenomenon of exotic blocks† enclosed in stay-at-home over-

* Elsewhere they (or probably only Gansser) claim these rocks as pre-Cretaceous (ref. 11, p. 184).

† The Tibetan blocks enclosed in the igneous complex are quite rightly called exotic blocks, but I have already discussed their relationships. Here I am only concerned with exotic blocks enclosed in sediments of Himalayan Cretaceous.

ridden sediments is one that is thoroughly familiar to students of the Alps. Again and again the question arises: Was this particular block introduced by sedimentary processes, such as land-slipping assisted by tunamis (earthquake-generated sea-waves), or by mechanical processes more directly connected with the operation of thrusting? In the present district there is, south-west of the Chaldu Pass (Fig. 2), a very prominent set of Tibetan sedimentary blocks, with Lias lettered L in Fig. 3. They are linked together by the customary igneous complex, including at one place pillow lavas, so as to constitute a unit three miles long, which has been carefully discussed by von Krafft under the heading "Area South of Kiogar Plateau" (ref. 3, p. 162). Though von Krafft was much averse to receiving aid from earth movement in his major problem, he clearly realized that the emplacement of this conspicuous assemblage of Tibetan and igneous rocks in the heart of the Himalayan Cretaceous sediments must be ascribed to folding and thrusting of some sort. Heim and Gansser confirmed this opinion and, calling the whole the "Chirchun thrust sheet", described it in architectural terms as a "tectonically lower exotic story", standing well below the main exotic story represented by the thrust-sheet that caps the Kiogar summits (ref. 11, p. 159). Several other exotic blocks included in the Cretaceous sediments of the district have been ascribed by the same three authors to mechanical introduction, and in all cases I agree.

In reading of these occurrences I have come to wonder whether the mechanism involved has not mostly depended upon outward flow of the unconsolidated Cretaceous clays when these have found themselves unevenly loaded by the advance of the Tibetan thrust-mass. Movement of clay under unequally distributed load is known to every civil engineer. Let me recall three representative examples.

(1) The Glengarnock iron foundry in Ayrshire piled up a great heap of slag on a clay surface. Presently the bottom of a neighbouring lake slowly rose and exposed the pile foundations of a forgotten crannog (lake village).

(2) Members of the Geological Survey have recently published detailed descriptions of adjustments by flow and rupture which have occurred again and again in response to changes of load dependent upon the protracted erosion of the valley systems of the counties of Northampton, Rutland and Lincoln. The main clay involved belongs to the Liassic formation of Mid Mesozoic age[20].

(3) At the foot of Beachy Head, the Chalk of the 500-ft. cliff is underlain by Upper Greensand and mobile Gault Clay, all three belonging to the Cretaceous System. Most of the chalk lies undisturbed; but its bottom portion, together with the greensand and gault, shows wonderfully complicated repeated small-scale thrusting, presumably due to outward upward flow of the yielding clay. The movement thus recorded very probably followed upon the marine erosion that has cut the present-day cliff (for the observational facts see Clement Reid, 1888, and Bull and Milner, 1925; for the interpretation see Hollingworth and others, ref. 20, p. 33).

My opinion is that most of the exotic blocks of the Kiogar-Chirchun district, in so far as they are included in the local Cretaceous sediments, are landslips in a very special sense, landslips that have slipped up and out from below the buried bottom of the advancing thrust-mass, rather than down and out from its uncovered front.

## Conclusion

A Tibetan thrust-mass invaded a Himalayan stretch of Tethys sea bottom, already occupied by submarine volcanoes. Driven underground, these volcanoes maintained a guerrilla attack by injection of molten material from below. Wear and tear due to withdrawal of overrun, overloaded mobile sediments added to the general confusion.


1 Schardt, H., *C.R. Acad. Sci., Paris*, **117**, 707 (1893); *Arch. Sci. Phys. et Nat., Genève*, 3rd ser., **30**, 570 (1893).
2 Griesbach, C. L., *Rec. Geol. Surv. India*, **26**, 19 (1893).
3 Krafft, A. von, *Mem. Geol. Surv. India*, **32**, 127 (1902).
4 Diener, C., *Mem. Geol. Surv. India*, **36**, 132 (1912).
5 Griesbach, C. L., *Rec. Geol. Surv. India*, **26**, 25, which carries an editorial note that "Mr. Middlemiss does not accept this explanation" (1893).
6 Griesbach, C. L., *Compte Rendu IX Sess. Con. Géol. Internat.* (Vienna, 1903), **2**, 550 (1904).
7 Diener, C., *Mem. Geol. Surv. India*, **28**, 21 (1898).
8 Diener, C., *Mem. Geol. Surv. India*, **36**, 139, 140 (1912).
9 Suess, E., *C.R. Acad. Sci., Paris*, **139**, 714 (1904).
10 Bailey, E. B., *Bull. Geol. Soc. Amer.*, **47**, 1722 (1936).
11 Heim, Arnold, and Gansser, A., *Mém. Soc. Helvétique Sci. Nat.*, **73**, 174, 184 (1939).
12 Griesbach, C. L., *Mem. Geol. Surv. India*, **23**, 83, 84, 130, 155 (1891).
13 Lydekker, R., *Mem. Geol. Surv. India*, **22**, 111 (1883).
14 Wadia, D. N., *Rec. Geol. Surv. India*, **68**, 419 (1935).
15 Lydekker, R., *Mem. Geol. Surv. India*, **22**, 116 (1883).
16 Bailey, E. B., *Geol. Mag.*, **81**, 99 (1944).
17 Bailey, E. B., "Tertiary and Post-Tertiary Geology of Mull, Loch Aline and Oban", *Mem. Geol. Surv.*, 120 (1924).
18 Reid, C., and Dewey, H., *Quart. J. Geol. Soc.*, **64**, 267 (1908).
19 Suess, E., "La face de la terre", **3**, 1497–1505 (de Margerie Ed., Paris, 1918).
20 Hollingworth, S. E., Taylor, J. H., and Kellaway, G. A., *Quart. J. Geol. Soc.*, **100**, 1 (1944).


# SCIENTIFIC COLLABORATION BETWEEN INDIA AND BRITAIN

A COUPLE of months ago, a delegation consisting of six of India's leading scientific men arrived in Great Britain to study the organization of scientific research and of industrial research and development. The party consisted of Dr. Nazir Ahmad, director of the Cotton Technological Laboratory, Matunga, Bombay; Sir Shanti S. Bhatnagar, director of scientific and industrial research, India; Sir Jnan Chandra Ghosh, director of the Indian Institute of Science, Bangalore, and president of the National Institute of Sciences of India; Prof. S. K. Mitra, Calcutta, chairman of the Radio Committee of the Board of Scientific and Industrial Research; Prof. J. N. Mukherjee, professor of chemistry, University College of Science and Technology, Calcutta; and Prof. Meghnad Saha, of the University College of Science and Technology, Calcutta. The visit came to an end on December 1, when they left for a similar tour in Canada and the United States. On the previous day, at a farewell luncheon in London, Prof. Mitra summed up, on behalf of the mission, the impressions which they had received. He said:

"It is just over seven weeks since we arrived in Great Britain. Our visit to this country as guests of His Majesty's Government will presently be coming to a close. During our stay here we have received nothing but kindness, courtesy and, from all concerned, the desire to meet our slightest wishes. I take this opportunity of thanking most sincerely on behalf of my colleagues, His Majesty's Government, the Royal Society, the India Office and the Office of the High Commissioner for India for the trouble and care they have taken to make our visit as profitable as possible.

"On the eve of our departure, we are being asked by our friends about our impression of war-time England. To this we say that we have been greatly impressed by the wonderful spirit of team-work of the people, by the way in which the human power and the material resources of the country have been mobilized to fight the enemy and by the steadfastness of your will to win. In particular, in the matter of organizing scientific research, in which we were specially interested, we were struck by the manner in which scientific talent throughout the country has been mobilized and researches in the different branches of science co-ordinated to produce the most fruitful result in the quickest possible time. We were also delighted to see that the industries directly responsible for the huge war productions have realized the importance of scientific research. We felt that without this collaboration between science and industry on one hand and the Government on the other, the successful prosecution of the War would have been an impossibility. We are sure that this new spirit of collaboration for the common cause will continue after the War and find its way to our country for constructive work.

"We are also being asked if our mission in Great Britain has been a success. Has it been worth the time and trouble that His Majesty's Government has spent on this visit of ours ? To this we gratefully reply that we have seen and learnt whatever we wanted to see or learn. We have made contacts with the most distinguished men of science, industrialists and social workers of the country. Further, what to us has been of the utmost importance, we have had the fullest opportunity of studying the method of organizing scientific research for national needs to which I referred just now. We have visited many large-scale industries and have been taken round the most complicated manufacturing processes by the directors of the industries themselves. To us this has been a kind of a revelation. We now understand how much technical talent, large-scale organization and sense of team-work are necessary for efficient running of such industries. We hope to enlighten our countrymen on these matters when we return to India.

"One of our colleagues very aptly remarked that for the last seven weeks we were being put through an intensive course of adult education. So far as this aspect of the visit is concerned, we think it has been a success, because we hope we have not proved ourselves to be students who shirk work. Our object in coming to Britain, however, was not only to educate ourselves, but also at the same time to acquaint the people of Britain, by free and frank discussion and exchange of views, with our problems and needs. If by our visit we have, even in a small measure, been able to achieve this, we shall consider that our mission has been a complete success.

"The discoveries and inventions of science have annihilated space and time. We can now flash across space news which will go round the earth seven times in one second. We can cover distances in hours which formerly would have taken days. The world has in effect grown smaller. A result of this has been that the different nations of the world are being brought into closer and more intimate contact. In future, the different nations, big or small, will have to march together, whether they will or not. But this marching together will only be a source of strife and conflict if the different nations do not keep pace with each other. Nations which for some reason or other are left behind will be a drag on those moving forward and, by causing friction, will act as a brake on general progress. It is therefore the duty of the advanced nations, in their own interest, to see that none may be lagging behind, and to lend a helping hand to those who may unfortunately be so.

"I believe that it is the duty of every nation to strive for progress, as it is the endeavour of the plant to seek light. India has for a long time failed in this duty. It is no use discussing who has been responsible for this inaction. India is now striving for progress, and we are sure you will be ready to help us in our endeavour to seek light and freedom—freedom from want.

"In conclusion, I would thank, on behalf of my colleagues, all those who for the past seven weeks have been responsible for arranging our programmes, planning our visits and, in a hundred other ways, doing all that was necessary to make our visit as useful and as pleasant as possible. It is difficult to express adequately our gratitude to them for all they have done for us. The memory of this very pleasant visit, which has forged as it were a link of goodwill and fellowship between the scientific workers of your country and ours, will always be cherished by us. We shall be leaving the shores of Great Britain in the confident hope that India, just as she has been a partner of Great Britain in her struggles and tribulations in the dark days of war, will also be a partner of her prosperity in the days of peace in the near future."

# OBITUARY

## Sir Arthur Eddington, O.M., F.R.S.

THE death on November 22, at the age of sixty-one, of Sir Arthur Stanley Eddington is a great loss to science. In these days of specialization in science, it is given to few to have so wide a range of interests and to make contributions of outstanding merit in such diverse fields as he did. He combined to a unique degree an appreciation of the significance of new developments with great powers of mathematical analysis and keen physical intuition. A gifted expositor of the newest trends in physics, he was able to describe the most abstruse theories in clear and simple language; his name and writings were known throughout the world.

Eddington was born on December 28, 1882, at Kendal, Westmorland, of a Quaker family, his father being the headmaster of the Friends' School at Kendal. In 1902 he entered Trinity College, Cambridge, after having carried all before him at Owens College, Manchester. In the Mathematical Tripos of 1904 he was Senior Wrangler and in the following year was placed in the first division of the first class of Part II of the Tripos. In 1907 he was Smith's Prizeman and was elected to a fellowship at Trinity College.

In 1906 Eddington was selected by Sir William Christie, the Astronomer Royal, to fill the vacancy in the post of chief assistant at the Royal Observatory, Greenwich, caused by the appointment of F. W. Dyson as Astronomer Royal for Scotland. At Greenwich, he obtained experience in observational astronomy and a familiarity with its problems which were to stand him in good stead. Though his interests were primarily in theoretical investigations, he was able to appraise the value of observations and to test theoretical conclusions by means of the data

provided by observation. He discussed the observations made with the Airy reflex zenith tube and when, as the result of this discussion, it was decided to discontinue these observations and to employ the Cookson floating zenith telescope, loaned by the Cambridge Observatory, for the determination of the variation of latitude and of the constant of aberration, he planned the programme of observation with this instrument.

But Eddington's main interest at this time was in stellar motions. Kapteyn had but recently announced his discovery of the two star-streams. A rapid increase in knowledge of the proper-motions and radial velocities of the stars was taking place. Eddington used the new material, discussed it thoroughly, and confirmed and amplified Kapteyn's conclusions. In 1914 his "Stellar Motions and the Structure of the Universe" was published. This work contained an account of his own researches, but this was made subservient to the wider aim of giving an account of the many recent discoveries in sidereal astronomy and co-ordinating them to present, so far as was possible at the time, a coherent description of the stellar universe. In each of the main fields in which Eddington worked, he followed the same plan of publishing a connected account of the new advances, incorporating the work of others; students and investigators of these fields are greatly indebted to him for the valuable assistance which was thus provided for them.

In 1913 he was elected to the Plumian professorship of astronomy at Cambridge, which had become vacant through the death of Sir George Darwin; and the next year, after the death of Sir Robert Ball, he was appointed director of the Cambridge Observatory. In 1916 he took up the study of the radiative equilibrium of the stars. Schwarzschild had developed in 1906 the theory of the radiative equilibrium of a star's atmosphere, but did not apply the theory to the interior of a star. Eddington found that the extension of the formulæ to the interior of a star was not difficult. The theory was thought at first to be applicable only to the diffuse giant stars; it was considered that in the interiors of the dwarf stars, with their much greater mean densities, there would be an appreciable departure from perfect gas laws. The theory indicated that the bolometric magnitude of a gaseous star is independent of its stage of evolution and depends only on its mass. But in 1924, as the outcome of a careful discussion of all the reliable determinations of stellar masses, he found that the formulæ of the theory predicted correctly the absolute magnitudes of all ordinary stars, regardless of whether they were giants or dwarfs.

This discovery of the correlation between the masses and the luminosities of the stars was a result of outstanding importance. It showed that dense stars, such as the sun, obeyed the laws of a perfect gas; it also necessitated a complete revision of the then accepted views of stellar evolution. The two branches of the familiar Russell-Hertzsprung diagram must either represent loci of equilibrium points or, if there was evolution along them, it must be accompanied by appreciable loss of mass. The white-dwarf stars did not satisfy the mass-luminosity relationship; Eddington came to the revolutionary conclusion that the mean density of 53,000 of the companion of Sirius was not absurd and should be accepted; he pointed out that, if this density were correct, there should be an Einstein shift of its spectral lines of about 20 km. per sec., which was shortly afterwards confirmed by Adams at Mount Wilson. Eddington also investigated the problem of the Cepheid variable stars, on the hypothesis that their light variations were caused by periodic pulsations, and was able to account for the period-luminosity relationship obeyed by these stars, which had been found by Miss Leavitt at Harvard from the study of Cepheid variables in the Magellanic Clouds. In 1926 Eddington gave a connected account of these investigations in "The Internal Constitution of the Stars", while "Stars and Atoms" (1927) gave a fascinating and graphic description of the new results in a form intelligible to the general reader.

In 1926 Eddington gave the Bakerian Lecture of the Royal Society, taking as his subject "Diffuse Matter in Interstellar Space"; this was an important contribution to the understanding of the nature of the interstellar clouds. He found that ionization and capture form the main process of interchange between radiant energy and atomic kinetic energy in diffuse gas, and that this tended to raise the temperature to the level of the effective temperatures of stars, independently of the dilution of radiation. He modified the usual equilibrium formulæ for the amount of ionization to apply to matter in a field of evenly diluted radiation. The relative abundance of sodium to calcium was found to be very much greater than on the earth; the tremendous preponderance of hydrogen over all other elements was not realized at that time, and Struve later showed that the discordance was much reduced when it was assumed that hydrogen supplied the overwhelming majority of the free electrons. Eddington concluded that the stationary sodium and calcium lines in the spectra of early-type stars were produced by absorption by the interstellar cloud; but found that the dimming of distant stars by interstellar gas could not be accounted for unless it was assumed that these contained non-gaseous (meteoric) matter. This conclusion has since been amply confirmed.

Concurrently with these investigations, Eddington had also been occupied with the theory of generalized relativity. The War of 1914–18 had disrupted scientific intercourse, and Einstein's important papers were generally unknown in Great Britain. Eddington had received a copy from the Dutch astronomer, de Sitter, in 1917; he immediately accepted the new theory, perceiving its great importance. His "Report on the Relativity Theory of Gravitation", prepared for the Physical Society in 1918, provided the first account of the new theory in the English language and did valuable service in bringing the theory to the notice of British men of science. Many were converted to it; but many others, because of its revolutionary conceptions and the employment in its mathematical development of the tensor calculus, with which physicists and applied mathematicians were not generally familiar, were inclined to suspend judgment. The theory had accounted for the unexplained motion of the perihelion of Mercury, but further observational confirmation was needed to convince the sceptics. Sir Frank Dyson found that the total eclipse of the sun on May 29, 1919, would provide a particularly favourable opportunity for testing Einstein's prediction of the amount of the deflexion of rays of light by the sun. It was decided to proceed with the necessary preparations at Greenwich for two expeditions, to Brazil and the Island of Principe, though the state of the War at the time gave little hope that it would be possible for the

expeditions to set out. But the end of the War came in time, and Davidson and Crommelin from Greenwich went to Brazil, while Eddington and Cottingham went to Principe. Both expeditions made successful observations, and the results obtained supported Einstein's prediction of the amount of the deflexion, and did much to secure general acceptance of the theory. In "Space, Time and Gravitation" (1920) Eddington gave a non-mathematical account of the theory, to which he prefixed the very appropriate quotation from "Paradise Lost":

Perhaps to move
His laughter at their quaint opinions wide
Hereafter, when they come to model heaven
And calculate the stars: how they will wield
The mighty frame: how build, unbuild, contrive
To save appearance.

About this time there appeared a spate of popular accounts of the theory, but none could compare with Eddington's masterly presentation. In 1923 he followed this with "The Mathematical Theory of Relativity", which included an account of his own important contribution—a generalization of Weyl's theory of the electromagnetic and gravitational fields, based on the notion of parallel displacement. He emphasized that there must be woven into the structure of the world a standard of length making possible the comparison of lengths at different points in space-time.

Much of Eddington's later work was concerned with the development of the cosmological aspects of relativity theory and with the unification of quantum theory and relativity theory. Observations had shown that the external galaxies were receding from our own galaxy and from each other with speeds proportional to their mutual distances apart. This gave rise to the conception of the expansion of the universe. The small popular book "The Expanding Universe" (1933) gave an account of the phenomena to be expected in a finite expanding spherical universe, of the type first suggested by Einstein and later developed by the Abbé Lemaître. Eddington sought to find relations between the radius of curvature of space, the recession-velocity constant of the external galaxies, the number of particles (or the mean density of matter) in the universe and the physical constants, such as the ratio of the mass of the proton to that of the electron, the ratio of the gravitational to the electric force between a proton and an electron, the fine-structure constant and the velocity of light. The connexion between the constant of gravitation and Planck's constant was obtained by treating an Einstein universe first by relativity theory and then by wave-mechanics applied to the system of particles forming that universe. The mathematical account of the theory was given in "The Relativity Theory of Protons and Electrons" (1936) and was revised and completed in his lectures before the Dublin Institute for Advanced Studies, entitled "The Combination of Relativity Theory and Quantum Theory" (1943). These researches, to which Eddington gave much time and thought, have not yet carried general conviction, though the agreement between observed constants and the values found by pure reasoning are extraordinarily close. The extremely abstruse and complex nature of the investigations, which few can claim to have thoroughly understood, is no doubt responsible in some measure, but the purely deductive nature of the theory is an important contributory factor. Eddington wrote that:

"An intelligence, unacquainted with our universe, but acquainted with the system of thought by which the human mind interprets to itself the content of its sensory experience, should be able to attain all the knowledge of physics that we have attained by experiment. He would not deduce the particular events and objects of our experience, but he would deduce the generalizations we have based on them. For example, he would infer the existence and properties of radium, but not the dimensions of the Earth".

This is a philosophy of science that does not command general acceptance to-day. Nevertheless, it may well be that generations yet to come will regard Eddington's recent work as one of the most important and significant advances in science.

In "The Nature of the Physical World" (1928) being the Gifford Lectures for 1927, and "New Pathways in Science" (1935), being the Messenger Lectures at Cornell for 1934, Eddington dealt with the new developments in science—the theory of relativity, quantum theory, the principle of indeterminacy, the expansion of the universe, etc.—and with their effect on philosophical thought. Both books were essentially concerned with the question: What kind of knowledge does science give us? He showed that in dealing with the universe, science is confined to investigating its structure; it can tell us nothing of the nature of that which possesses that structure. It was not so much the particular form that scientific theories have now taken that is important, for they may in time give way to some fuller realization of the world, as the movement of thought behind them changes. Whatever changes may come, it will never be possible to go back to the old outlook. Eddington was a master of the English language, and these lucid expositions did more than any other books to make the intelligent layman aware of the new trends in science and of their philosophical implications.

Eddington was elected a fellow of the Royal Society in 1914 and was awarded its Royal Medal in 1928. He was president of the Royal Astronomical Society during 1921–23, and foreign secretary from 1933, and was awarded its Gold Medal in 1924. He was awarded the Bruce Gold Medal of the Astronomical Society of the Pacific in 1924. He was president of the Physical Society during 1930–32. He received honorary doctorates from twelve universities, and was honorary member, foreign member or foreign associate of many learned societies in Europe and America. He was created a Knight Bachelor in 1930 and received the Order of Merit in 1938. He was elected president of the International Astronomical Union at its last General Assembly in 1938. He was a great ambassador of science, who travelled and lectured widely.

Many in Great Britain mourn the passing of a friend and colleague while still in the zenith of his intellectual powers; their sense of loss will be shared by many others in all parts of the world, who have admired from afar his achievements and have received instruction and stimulus from his writings.

H. SPENCER JONES.

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THROUGHOUT his career as an astronomer, Sir Arthur Eddington's connexion with the Royal Astronomical Society, both formal and scientific, was close and intimate. He was elected a fellow in 1906, was president during 1921–23 (a period of office which included the celebration of the centenary of the Society), received its Gold Medal in 1924, and

after H. H. Turner's death eventually inherited his office as foreign secretary, his corner-seat in the front row at meetings and, it is fair to add, his place in the affections of the fellows. He used its *Monthly Notices* as the medium of publication for almost all his fundamental contributions to science. Thus his early papers on star-streaming appeared there; his initial papers on Cepheid pulsations in 1916 appeared there; and these led in turn to his beautiful theory of the radiative equilibrium of the stars, in which the flow of radiation was first recognized as a basic process in the transfer of energy in stellar interiors, and in which the mechanical pressure of radiation was first shown to be an important element in the mechanical equilibrium.

The steps by which Eddington successively uncovered the dependence of relative radiation pressure on molecular weight, the dependence of that on ionization, the importance of radiation pressure in perhaps fixing the order of magnitude of the masses of the stars, and the probable gaseous character (on his hypotheses) of the whole interior of a star, are among the most fascinating in the history of mathematical physics. They led in turn to his recognition of the mass-luminosity law obeyed indifferently by giant and dwarf stars, which, however unsatisfactory still in its theoretical aspects, is an important supplement to our methods of ascertaining stellar masses. These steps accomplished, he returned to the question of the *chemical* constitution of stellar interiors, concluding (with others) that they are mostly hydrogen; and he completed in various ways his theory of pulsating stars. Further, he was a pioneer in the study of diffuse matter in interstellar space.

Eddington was ever a fighter for his ideas, allowing of no compromise when he had considered a matter and properly made up his mind. Many astronomers still remember titanic debates at the Royal Astronomical Society in which Eddington was protagonist and supreme defender of his own views; he asked no quarter, and he gave none. I think that a time may come when some of Eddington's more provocative conclusions on stellar structure may have to be re-valued, and that Eddington sometimes closed his eyes to the possibility of alternative attitudes to some of the scientific questions of the day. But as one who, in spite of wrestling with Eddington in public and in private in scientific disagreement, maintained always the happiest and friendliest personal relations, I join with heart-aching sincerity in the universal grief among the astronomical fraternity for one taken from us so unexpectedly, for a leader whose writings have been such an inspiration to lovers of astronomy and astrophysics, and for a dear friend to, and encourager of, all that was gentle, and wise, and witty, and satisfying in the sciences of which he was the devoted servant. Truly he was a great man.

E. A. MILNE.

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ALL physicists deplore in the death of Sir Arthur Eddington the passing of a great leader in their science, whose genius they acknowledge as freely as they admit, in many cases, their inability to follow him in his most daring and difficult advances. These particular advances, however, form only part of his life's work: certain of his most striking achievements are based upon bold and penetrating applications of simple physical conceptions to problems not contemplated when they were elaborated. Nuclei stripped of all their electrons—of their crinoline, as Sir Alfred Ewing termed it—are a simple corollary of the nuclear theory of the atom: the pressure of radiation, measured in the laboratory, had been invoked to explain the behaviour of the tails of comets. Eddington seized upon these conceptions and, combining them with the laws of gravitation, evolved a theory within the comprehension of the ordinary physicist, which explained beautifully the general features of stellar structure and stellar evolution. Bare nuclei, together with the electrons freed from their normal orbits, readily represent a gas of great density, such as was required to explain the compactness of the dark companion of Sirius and other white dwarfs. By bold imaginative conceptions of this kind, combined with technical mathematical powers of the highest order, Eddington made of the stellar universe a physics laboratory where somewhat extreme conditions prevailed, but nevertheless a physics laboratory.

His early work on relativity and his observations that established the bending of light in a gravitational field were likewise matters which appealed to every physicist. His later work on the connexion of the theories of relativity and quantum mechanics, which enabled him to relate the velocity-distance relation of the spiral nebulæ to the number of elementary particles in the universe, and his mysterious number 137, are hard matters for many of us, but we feel that it is impertinence to criticize that which we do not understand, when it comes from a master. Here are great attempts at the solution of great problems, made in a manner that commands respect and admiration.

Eddington was a man of extremely wide interests in physics. In 1920 he wrote for the Physical Society a report on the Relativity Theory of Gravitation, which met an urgent need, and he was president of the Physical Society during 1930–32. He took a very active interest in the doings of the Society, and his presidential address on "The Expanding Universe" will be long remembered. When in the chair he showed a surprising familiarity with almost every aspect of physics that came before the meeting.

Eddington's more popular works, such as "Stars and Atoms", had a wide appeal to all interested in physical science. Physicists rejoiced to see the esoteric delights of their subject exposed with such perception, daring and vivacity. The width of Eddington's reading was shown nowhere so clearly as in his quotations, always apposite, which were drawn from an astonishing variety of authors. To the book just cited is prefixed a most apt citation from the Swiss anatomist and physiologist Albrecht von Haller, whose poetical works cannot be familiar to most English men of science,

> "Ich häufe ungeheure Zahlen,
> Gebürge Millionen auf,
> Ich setze Zeit auf Zeit und Welt auf Welt zu
> Hauf",

and elsewhere Descartes, Lucretius, Omar Khayyam, H. G. Wells, Isaac Newton, Cardinal Newman, Lewis Carroll, Milton, Shakespeare and the Bible among others are called upon.

It can be seldom, if ever, that one who was a master of the most abstruse technicalities of scientific thought could have been able to express himself as lucidly, as charmingly and as individually as Eddington does in his more popular works. He had in him something of the prophet, but one with a very much more amiable and conciliatory style in his writings than that of most prophets. E. N. DA C. ANDRADE.

# NEWS and VIEWS

## Sir D'Arcy W. Thompson, C.B., F.R.S.: A Professorial Record

"YOU will never live to my age, without you keep yourselves in breath with exercise, and in heart with joyfulness"—and so successfully has Sir D'Arcy Thompson fulfilled the injunction of Sir Philip Sidney that ere Christmas Day he will have completed sixty years as professor of natural history. On December 22, 1884, at the age of twenty-four, he was elected, as its first incumbent, to the chair of natural history in the newly opened University College of Dundee. Here, as at Edinburgh Academy, he was fortunate in his environment of good companions: his unsuccessful competitors for the chair included J. T. Cunningham, W. E. Hoyle and Patrick Geddes; his new colleagues in due course numbered among them as young professors who later gained wide recognition, Sir Patrick Geddes, who had accepted the chair of botany, Sir Alfred Ewing, principal and vice-chancellor of the University of Edinburgh, Sir William McCormick, secretary to the Carnegie Trust for the Universities of Scotland, Sir James Walker, professor of chemistry in the University of Edinburgh, and Sir William Peterson, principal of McGill University, Montreal. In 1897, University College, Dundee, which had begun as an independent institution, became an integral part of the University of St. Andrews, and in 1917, on the retiral of Prof. W. C. McIntosh from the chair of natural history in St. Andrews, which he had occupied since 1882, it was a fitting and natural move that D'Arcy Thompson should be transferred to the senior chair. His predecessor retired in his seventy-ninth year; in his eighty-fourth Sir D'Arcy continues to teach with vigour and to take part in many activities outside the University.

In his early years in Dundee, Sir D'Arcy Thompson, like many another, was drawn to the marine invertebrates, particularly to the Cœlenterates and Bryozoa, and began the building up of a collection which eventually contained an unusual number of authenticated representatives of invertebrate species. But his interests were wide, and his appointment as a delegate to the Behring Sea Fisheries Conference in 1897 and his selection in the following year to be scientific member of the Fishery Board for Scotland gave public recognition to what has remained a main aspect of his scientific work. For forty years, that is until the Fishery Board was disbanded recently, he retained its scientific membership and guided the development of its scientific investigations; and his own published papers on the statistics of fisheries and the distributional occurrence of rare species of fishes show his personal predilection. This was but one of many interests—the classics and the natural history of the ancients, the perfection of adaptation in many creatures, the influence of physical law in moulding the parts of animals, growth and form; but perhaps the fundamental and rejuvenating interest throughout has been the outlook of the born naturalist, which finds its satisfaction by the shores of the North Sea or in the woods of the Spey valley.

## Conway Evans Prize: Sir Thomas Lewis, C.B.E., F.R.S.

THE presidents of the Royal Society and of the Royal College of Physicians have awarded the Conway Evans Prize to Sir Thomas Lewis, in recognition of his great contribution to medical knowledge on the normal and abnormal mechanisms of the heart and circulation of the blood. This prize, in accordance with the will of the late Dr. Conway Evans, who was medical officer for the Strand District, is awarded from time to time for scientific work of outstanding distinction. It was first given to Sir Charles Sherrington in 1927 and since then to the late Dr. John S. Haldane in 1933, and to Sir Frederick Gowland Hopkins in 1938. It will be seen that so far the prizes have been awarded infrequently with the intention that they should be given only in recognition of outstanding contributions to science, thus fulfilling the intention of the donor. Sir Thomas Lewis has worked essentially in a field which he has called 'clinical science', and he has clearly indicated how the modern developments of science in general can be applied to the many problems of medicine at the bedside.

## An International Office for Education

DR. HARLOW SHAPLEY, speaking on behalf of the U.S. Office of War Information, recently broadcast an address in the United States with reference to an International Office for Education. He pointed out that both education and lack of education play a part in our present world-wide troubles. The high technical training in the armed forces, and also in the war factories that back the armies and navies, represents a type of education that is indispensable in our effort to bring back peace and social sanity to the world. But it is a lack of education—a deficiency in elementary social education, or a perversion of it, that has brought the madness of totalitarian war upon us. In too many parts of the world the fundamental education has not been planned so as to teach us how to live and let others live intelligently in the kind of world that modern technical civilization has given us. In the social evolution that is necessary for a good and progressive world society, we must have a basic education so widespread, and so democratic in spirit, that demagogues cannot easily lead us into inhuman and selfish and false creeds. We must have, if possible, in all grades of our educational systems, the desire and freedom to question statements, to challenge dogmas. We must question our teachers, and not be blindly led by them. We should encourage internationalism in our leaders. We must have, especially in our elementary schools, a universal recognition that there are international allegiances as well as national responsibilities, that we are a part of a world-wide human society.

It is to facilitate the reform or the improvement of educational systems in all countries that the setting up at the earliest time practicable of an International Office for Education is suggested. Such an office is not intended to be a temporary affair, concerned with rehabilitation problems. Such reconstruction work is necessary and immediately urgent. Steps toward carrying it through are well under way. But of necessity, rehabilitation is a re-establishment of the conditions that existed before the blight of war passed over the land. Rehabilitation is in a sense backward-looking, rather than forward-look and evolutionary. The advocated International

Office for Education should be set up for all time, and be oriented toward the future, toward a socially improving future. Particular educational systems in any country are not suggested. Rather, the International Office should act as a clearing-house for educational ideas, an information centre for the educators and for the educational bureaux and ministries that need guidance and specific assistance in the improving of their work. In the specialized sciences and arts there have long been useful international unions. In their limited fields such organizations have shown how relatively simple it is for the people of all nations to co-operate. What has been done in the sciences can certainly be done in the general educational field. The great usefulness of the International Labour Office during the past two decades shows how important, for international understanding, an organization of this sort can be. That the establishment of an International Office of Education appeals to Americans of all sorts has been indicated by the rapid support received from scores of important organizations—from church, labour, industry and education—and from numerous members of the National Congress. It is hoped that the American Government will join with the other free governments of the world, in an official recognition of the essential part of education in the planning for a better and more peaceful world.

## Visual Aids in the Schoolroom

THE remarkably comprehensive and suggestive paper recently read at the Royal Society of Arts by Mr. R. W. Moore, headmaster of Harrow, calls for special comment. The progressive teacher, he said, is alive to the uses of the epidiascope, and films have established themselves as an important subsidiary in schools. In the past, visual factors have been neglected, no doubt. Yet, he said, we must ask ourselves whether worse dangers than those of neglect are not involved in the uncritical multiplication of visual aids now prevalent in some quarters. Illustration is confused with explanation. Excess of detail, leading to distraction and irrelevance, abounds. True, the development of new processes promises a great enrichment for teacher and pupil; but our chief need is that of a psychology of education which will take account of these visual adjuncts and order them. The subjects which most need visual aids, said Mr. Moore, are science, history and geography. Of the three, he proceeded, science is the best case, because observation has long since been recognized as basic in the scientific tradition, and also scientific men have a professional bias towards, and a mechanical dexterity in, the manipulation of visual aids. History is the most difficult to accommodate to such aids. Geography stands between. It is the study of man in his natural environment. As a subject, it has only recently emancipated itself from the verbalism of the academic tradition. It should have its roots in observation and begin with local investigation. But how are we to extend the process towards a knowledge of world geography? How is the child in a poor London school to observe India and South America? Films are here intensely valuable, but the material available is sadly thin. The present needs are: (1) that research and experiment be made inside the teaching profession towards ascertaining what visual aids are appropriate to particular subjects and purposes, and (2) that there should be thorough co-operation between teachers and manufacturers before and during production.

## A Natural Elastic Polyester

SOME of the newest and most fascinating developments in applied science lie in the field of high polymers—and yet the story of high polymers, since they form the principal physico-chemical basis of life, is one of the oldest and most fundamental in the world. Most natural chain-molecules still cannot be synthesized by man; but he can build many others that are not found in Nature. Among the latter were thought to be the polyesters, first synthesized by Carothers and Arvin in 1929. It is reported now by A. R. Kemp and H. Peters (*India Rubber World*, **110**, 639; 1944) that what seems to be very likely a polyester constitutes the highly elastic skin that fits tightly round the seeds of *Smilax rotundifolia* Linn. The ripe berries usually contain three seeds about ½ cm. in diameter, each enclosed in a membrane about 0·003 cm. thick. On removal, the membrane is found to be stretchable by 300–400 per cent and to give then a typical X-ray fibre photograph with a probable fibre period of about 22½ A. This finding, taken in conjunction with chemical analyses carried out on the skins both before and after hydrolysis with alcoholic caustic potash, indicates that the main component is a polyester formed by the repeated condensation of a unit having 17 or 18 carbon atoms in the chain with two hydroxyl side groups, the suggested empirical formula of the monomer being $C_{18}H_{36}O_5$. The conclusions are for the present tentative, but they are by no means unconvincing, and the results of further investigation—very much worth while—will be awaited with interest.

## Earthquake in Japan

ONE of the most violent earthquakes of recent years was recorded by the seismographs at Kew, West Bromwich, New York and Bombay, and probably throughout the world, on December 7. At West Bromwich it was recorded at 4h. 48m. 38s. G.M.T., and the waves were so violent that the recording mechanism was upset. At Fordham, New York, the Rev. J. J. Lynch believes from a preliminary investigation of his records that two shocks were recorded, at 12.49 and 12.53 a.m. (local time). The Japanese News Agency stated that the Island of Honshu was affected, and that it was believed that the epicentre was in the Sea of Nshu. The Tokaido district was affected and also Shizuoka, Hamamatsu, Nagano and Nagoya, the third largest city of Japan. There was some damage to property and a seismic sea-wave affected Shizuoka. It appears unlikely that further details will be obtainable from Japan until the end of the War; but this was undoubtedly a very great earthquake, and when the records are examined closely the epicentre will be found more precisely.

## The Phosphorus Cycle in Nature

FOR his presidential address to the Geological Section of the Congress of the South Eastern Union of Scientific Societies, held on October 14, Dr. K. P. Oakley took as his subject "Man and the Migrations of Phosphorus". For some time after the earth's formation, the phosphorus cycle in the sea was simple, the phosphate ions being built up into the earliest forms of organic life and released again at their death, the only loss occurring through the precipitation of phosphate ions accumulated at the lower levels, with the formation of sedimentary rock phosphate beds. Following the emergence of life from the sea and the

colonization of dry land, a soil-plant-animal-soil cycle arose, from which phosphorus was removed in small quantities in the formation of bone beds, fossil fish or guano deposits. With the development of agriculture in historic times, however, the phosphorus cycle has been seriously upset, for systematic cropping reduces the reserves in the soil more quickly than they can be renewed from fresh sources. In the past few centuries man has attempted to restore the phosphorus balance by the use of fertilizers, derived largely from natural deposits; but he has also accelerated the transference of phosphorus from plant and animal life to the sea, thus speeding up its cyclical migration in a two-fold manner. Although this has been of undoubted benefit to man, it will ultimately lead to a state of bankruptcy with regard to the element. The world reserves of workable mineral phosphate are within measurable distance of exhaustion, and although new sources may be discovered, a planned economy in their utilization seems called for, as no substitute for phosphate exists and it is essential to the survival of a large human population. The address, which includes a historical account of phosphatic fertilizers, is to be published in the January issue of the *South Eastern Naturalist and Antiquary*.

## Mathematics in China

IN addition to work directly for the war effort and in spite of difficulties of communication, mathematicians in China are able to produce a considerable amount of new work of the highest quality. In particular, we may mention Prof. L. K. Hua, of the Tsing Hua University in Kunming, whose visit to Cambridge during 1936–38 will be remembered. The following information has been received through the British Council Cultural Scientific Office at Chungking. Prof. Hua has just completed a booklet on additive prime number theory which will be published by the Academy of Sciences of the U.S.S.R. The first of a series of papers on the theory of automorphic functions of a matrix variable has just been published in the *American Journal of Mathematics*. Related to this is a theory of modular functions connected with linear associative algebras, which is so far unpublished. Another field in which Prof. Hua has been working is that of the geometry of matrices, related to topological algebra. In addition, Prof. Hua has continued his studies in the geometry of numbers and, in extending theories due to Minkowski and Dr. K. Mahler, has discovered a new type of convex body.

## Astronomical Observations in Spain

IN the issue for 1944 of the *Boletín Astronómico Del Observatorio De Madrid*, E. Gullón supplies a résumé of the observations of solar prominences during September–December 1939. Owing to the removal of certain equipment from Valencia to Madrid and to other causes, observations could not commence before September 1. Sunspot observations during the same period were made by E. Gullón and Martín Lorón with the 20-cm. Grubb equatorial, and the results are shown on pages 14–16. Solar prominences during 1940 were observed by E. Gullón and the results are given in the same form as those observed during 1939. The last section of the bulletin deals with sunspot observations carried out by E. Gullón and Martín Lorón at Madrid and Valencia in 1940. Those at Madrid were made by means of a Herschel helioscope mounted on the 20-cm. Grubb equatorial, focal length 3 m., and those at Valencia were made with another equipment of a similar type on the 15-cm. Grubb, and with a focal length 2.20 m.

## Swedish-made Drugs

ACCORDING to the August issue of the *Anglo-Swedish Review*, a new local anæsthetic has been discovered which in several respects far surpasses novocaine, which Sweden had hitherto to import. This new anæsthetic has been named *LL* 30, the letters standing for the names of two young scientific workers Lövgren and Lundquist, and the figure representing the number of anæsthetic compounds tried and discarded during their six years of investigation. *LL* 30 is now being made on a commercial scale by the Astra concern of Södertälje not far from Stockholm, where penicillin is also being manufactured. Sulphonamide preparations are being manufactured from Swedish raw materials, and its price is now down to half that of the imported foreign preparations.

## Books on Historical Medicine and Science

THE annotated catalogue issued by Schuman's, 30 East 70th Street, New York, under the name of "Medical Miscellany List 'J' ", includes, besides a large number of miscellaneous works on medicine and science, two sections devoted respectively to neurology and psychiatry and war medicine. The miscellaneous works include books by Baillou on epidemiology, diseases of the skin by Alibert, anthropology by Blumenbach, physiological optics by Helmholtz, as well as the first fifteen volumes of the *Memoirs of the Royal Academy of Surgery of Paris*. Among the books on neurology and psychiatry are works by Brown-Séquard, Freud, Janet, Kraft-Ebing, Puschmann, Spallazani and Vesalius. The section on war medicine contains Hans von Gerssdorff's field book of surgery (1528), John Pringle's "Observations on the Diseases of the Army" (1765) van Swieten's "Diseases incident to Armies" (1776) and works on the American Civil War (1861–1870), including documents concerning the United States Sanitary Commission.

## Announcements

AFTER nearly two years in China, Dr. Joseph Needham, director of the British Council Cultural Scientific Office in China, has returned to Great Britain for consultations. He will be returning to China early in the New Year.

PROF. J. M. MACKINTOSH, professor of public health in the University of London, has been appointed dean of the London School of Hygiene and Tropical Medicine as from January 1, 1945.

AT the annual general meeting of the Scientific Instrument Manufacturers Association of Great Britain, Ltd., the following officers were elected: *President*, Mr. F. Wakeham; *Vice-Presidents*, Mr. J. Hasselkus and Mr. J. T. Offer; *Hon. Treasurer*, Mr. J. E. C. Bailey; *Hon. Secretary*, Mr. G. A. Whipple.

THE Association of Scientific Workers is organizing a conference to discuss the use of science in the post-war world, to be held at the Caxton Hall, London, S.W.1, during February 17–18, 1945. Further particulars will be obtainable in due course from the Association of Scientific Workers, Hanover House, 73 High Holborn, London, W.C.1.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Unification of the Theories of Photon and Meson

ONE of the puzzling features of the modern theory of matter is the considerable number of different ultimate particles: photons, neutrinos, negative and positive electrons, mesons, protons and neutrons. To each type of particle corresponds a certain type of field, and all these fields are supposed to exist simultaneously in space.

Attempts at unification were successful only in the frame of classical electrodynamics; it is possible to consider the electron as a singularity of the electromagnetic field. But this idea could not be adapted to quantum theory.

To-day, particles of any type are considered as quanta of the corresponding field (in the same way that photons are the quanta of the electromagnetic field), and their interaction can be described by a coupling of the fields. This interaction produces not only the phenomena of collision and combination of different particles, but also the self-energy of single particles, and is therefore the clue to the understanding of the different masses. But this theory is extremely complicated and has so far yielded no positive results.

It would, therefore, be of advantage to have a simple example where the interaction of two types of fields can be studied rigorously with the help of simple mathematics. I have found that the interaction of two fields with even spin provides such an example.

A field with spin 0 is described by a scalar wave function $\chi$. The simplest Lagrangian density as used in the elementary theory of the scalar meson is

$$\mathfrak{L}_0 = \tfrac{1}{2}(\nabla\chi)^2 + \tfrac{1}{2}\eta_0^2\chi^2, \quad . \quad . \quad . \quad . \quad (1)$$

where $\nabla$ means the 4-dimensional gradient $\partial/\partial x_\alpha$ ($\alpha = 1, 2, 3$; $x_1, x_2, x_3$ space co-ordinates, $x_4/ic$ time). The constant $\eta_0$ is connected to the rest mass $m_0$ by

$$\eta_0 = \frac{m_0 c}{\hbar} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

A field with spin 1 is described by a 4-vector wave function (components $\varphi_1, \varphi_2, \varphi_3, \varphi_4$); the most general Lagrangian density is

$$\mathfrak{L}_1 = \tfrac{1}{2}(\nabla\wedge\varphi)^2 - \tfrac{1}{2}\lambda(\nabla\cdot\varphi)^2 + \tfrac{1}{2}\eta_1^2\varphi^2, \quad . \quad . \quad (3)$$

where $\wedge$ indicates the vector product (with 6 components $\partial\varphi_\beta/\partial x_\alpha - \partial\varphi_\alpha/\partial x_\beta$) and . the scalar product. $\eta_1$ is again proportional to the rest mass.

If $\eta_1 = 0$ and $\lambda = 0$, one has the ordinary Maxwellian theory of the vacuum. The addition of the $\lambda$-term is of no great consequence as the solutions are usually restricted by the condition that the quantity

$$\Phi = \nabla\cdot\varphi \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

vanishes (Lorentz condition). If the term with $\eta_1$ is added, one has the vectorial meson theory.

Now I suggest that the interaction of these two fields should be considered, *assuming in both of them that the mass term is zero.*

$$\eta_0 = 0, \ \eta_1 = 0. \quad . \quad . \quad . \quad . \quad . \quad (5)$$

The simplest possible interaction is

$$\mathfrak{L}_{01} = \mu\chi(\nabla\cdot\varphi), \quad . \quad . \quad . \quad . \quad . \quad (6)$$

where $\mu$ is a constant of dimension reciprocal length. It is easy to see that no other independent interaction exists which is relativistically invariant and quadratic in the wave functions.

The total Lagrangian

$$\mathfrak{L} = \mathfrak{L}_0 + \mathfrak{L}_1 + \mathfrak{L}_{12} = \tfrac{1}{2}(\nabla\chi)^2 + \tfrac{1}{2}(\nabla\wedge\varphi)^2 - \frac{\lambda}{2}(\nabla\cdot\varphi)^2 + \mu\chi(\nabla\cdot\varphi) \quad . \quad . \quad (7)$$

then leads to the field equations

$$\nabla^2\varphi - \nabla\Phi = s, \quad . \quad . \quad . \quad . \quad . \quad (8)$$

$$\nabla^2\chi = \mu\Phi, \quad . \quad . \quad . \quad . \quad (9)$$

where

$$s = \nabla(\lambda\Phi - \mu\chi) \quad . \quad . \quad . \quad . \quad . \quad . \quad (10)$$

can be considered as a charge-current vector. From (8) one obtains the continuity equation for $s$:

$$\nabla\cdot s = 0, \quad . \quad . \quad . \quad . \quad . \quad (11)$$

which, however, is not an identity, but implies in virtue of (9) and (10)

$$\nabla^2\Phi = \frac{\mu}{\lambda}\nabla^2\chi = \frac{\mu^2}{\lambda}\Phi \quad . \quad . \quad . \quad (12)$$

Now one can establish wave equations for $\chi$ and each component of $\varphi$ separately, by applying the operators $\nabla^2$ and $\nabla^2 - \mu^2/\lambda$ to (8) and (9):

$$\nabla^2\left(\nabla^2 - \frac{\mu^2}{\lambda}\right)\chi = 0, \quad . \quad . \quad . \quad . \quad (13)$$

$$\nabla^2\left(\nabla^2 - \frac{\mu^2}{\lambda}\right)\nabla^2\varphi = 0. \quad . \quad . \quad . \quad (14)$$

These equations have solutions of the form of plane waves, representing particles with energy $E$ and momentum $\mathbf{p}$; for these solutions the operator $\nabla^2$ corresponds to multiplication with $(E/c)^2 - \mathbf{p}^2$. Hence there are two types of waves possible: one moving with the velocity of light corresponding to particles with rest mass zero, photons; the other with smaller velocity corresponding to particles with finite rest mass

$$m_0 = \frac{\hbar\mu}{c\sqrt{\lambda}}, \quad . \quad . \quad . \quad . \quad . \quad . \quad (15)$$

which behave, therefore, like mesons. A simple discussion shows that in the case of the photon $\chi = \Phi = 0$, three of the four components of $\varphi$ are arbitrary (the fourth being determined by the Lorentz condition $\nabla\cdot\varphi = 0$); whereas in the case of the meson $\chi$ and $\Phi$ are not zero and $\varphi$ has only a longitudinal component equal to $\chi$.

The result is that particles of spin 0 and 1 without rest mass are transformed by the simplest interaction into two new types of particles, one still having the rest mass zero (photon), the other a finite rest mass (meson).

Photon and meson seem to be different phenomena of the same quantized field. The theory as indicated here is over-simplified; for example, the wave functions are treated as real quantities, whereas there is evidence for the meson field being complex (for otherwise mesons could not carry electric charges). Moreover, the provisional character of these considerations is obvious as they exemplify how meaningless it is to neglect any kind of particle. All particles together form a single field of great complexity. One can venture the suggestion that, by adding to the scalar and vector fields treated here, a Dirac field

without mass term, the result will be a transformation into new types of particles with finite rest mass and spin $\frac{1}{2}$. This theory, however, will be much more complicated, since the interaction terms of the vector field $\varphi$ and the spinor field $\psi$ are of the third order (type $\varphi(\psi\psi)$ ). One has to apply perturbation theory, and it is well known that this has so far always led to infinite values of the self-energy. But recent investigations carried out by Dr. H. W. Peng, in my Department, have shown that this is due only to insufficient mathematics. Therefore it can be expected that Peng's method of secular perturbations will allow the mass problem to be tackled as sketched here.

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## Excretion of Penicillin in Man

PENICILLIN is rapidly eliminated from the human body, and 40–99 per cent of an injected dose can be recovered from the urine within four hours in normal cases. There is some evidence that the drug is actively secreted by the renal tubules[1,2]. In cases of severe azotæmic nephritis, penicillin has been demonstrated in the blood for so long as ten hours after a single injection, although in a normal person after a dose of 25–50,000 units it would have disappeared in three hours.

There were recently admitted to this Hospital two patients, both of whom had had incomplete abortions at the sixteenth week of pregnancy and both of whom developed extreme oliguria directly afterwards. In each case this condition lasted for ten days before recovery began, and during this period such urine as was passed consisted of a glomerular filtrate with evidence of little tubular function. This is shown by Table 1, from which it may be seen that even at high blood urea levels there was only a low urea concentration in the urine (cf. extrarenal azotæmia, in which urinary urea may reach 4 per cent), that chlorides were not retained even though the plasma values were far below normal (560–620 mgm. sodium chloride per 100 c.c.), and that creatinine was concentrated to a small extent compared with the 'normal' ratio of about 100[3].

TABLE 1. CONCENTRATIONS ARE GIVEN IN MGM. PER 100 ML., AND THE DAYS REFER TO THE NUMBER OF DAYS OF OBSERVATION.

| | Case I | | Case II | |
|---|---|---|---|---|
| | 2nd day | 10th day | 2nd day | 10th day |
| Urine vol. (ml.) | 15 | 180 | 165 | 150 |
| Urea in blood | 174 | 530 | 255 | 320 |
| Urea in urine | 170 | 600 | 800 | 600 |
| Chlorides (as NaCl) in plasma | 590 | 360 | 400 | 320 |
| Chlorides (as NaCl) in urine | 160 | 255 | 215 | 305 |
| 'Apparent' creatinine in plasma | 8 | 18 | 8 | 12 |
| 'Apparent' creatinine in urine | 6 | 9 | 67 | 50 |

These temporarily self-nephrectomized persons provided an opportunity of observing the fate of injected penicillin, for physiological as well as therapeutic reasons. 45,000 units of a preparation issued by the Therapeutic Research Corporation were injected intra-muscularly, and bacteriostatic assays were made upon serum samples at intervals afterwards. Bacteriostasis was measured in slide-cells, using the Oxford standard strain of *Staphylococcus aureus* as test organism. The results are given in Table 2.

TABLE 2.

+ = bacteriostasis.
± = partial bacteriostasis compared with control.

| | Hours after injection | Serum dilution | | | | | |
|---|---|---|---|---|---|---|---|
| | | 1/1 | 1/2 | 1/4 | 1/8 | 1/16 | 1/32 |
| Case I. | 3 | + | − | + | + | ± | + |
| | 7 | + | + | + | − | + | + |
| | 18 | + | + | + | + | − | − |
| | 26 | + | + | + | + | − | − |
| | 32 | + | + | ± | − | − | − |
| | 45 | + | + | − | − | − | − |
| | 72 | + | ± | − | − | − | − |
| | 107 | + | − | − | − | − | − |
| | 131 | − | − | − | − | − | − |
| Case II. | 1 | + | + | + | − | − | + |
| | 6 | + | + | + | − | − | + |
| | 20 | + | + | + | + | ± | − |
| | 26 | + | + | + | + | ± | − |
| | 48 | + | + | + | + | − | − |
| | 68 | + | ± | − | − | − | − |
| | 92 | + | − | ± | − | − | − |
| | 116 | + | − | − | − | − | − |
| | 116 (with penicillinase) | − | − | − | − | − | − |

In both cases urine samples collected during the test periods were assayed for penicillin by the ring test[4], but none contained detectable amounts.

The second patient was given a further injection of 47,500 units five days after the first. The 24-hour urine volumes on the succeeding days were 150, 480, 600 and 1,260 c.c. Her serum, taken three days after this injection, still caused complete inhibition of growth of staphylococci at a dilution of 1:1, and partial inhibition at 1:2 (effect abolished by penicillinase). On this occasion the urine excreted during the twenty-four hours following injection caused inhibition of growth in the ring test corresponding to $\frac{1}{2}$–1 unit of penicillin per c.c., but subsequent specimens caused negligible inhibition.

The failure to recover penicillin from the urines ($p$H 6·8–7·6, and preserved with toluene) of case II must have been due both to grossly impaired glomerular and tubular function. As judged by creatinine values, however, concentration of the urine by tubular reabsorption of water was still occurring to the extent of at least five times, although chloride reabsorption and urea excretion were greatly deficient. If penicillin were concentrated in the urine solely by reabsorption of water, it seems probable that it would have been sufficiently concentrated in the urine to have been detected in the ring test. However, such evidence for active tubular secretion is suggestive only.

The main conclusion to be drawn from these two cases is that in the absence of significant renal excretion of penicillin this drug is slowly inactivated in the body, but will nevertheless remain detectable for five days.

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[1] Rammelkamp, C. H., and Keefer, C. S., *J. Clin. Invest.*, 22, 425 (1943).
[2] Rammelkamp, C. H., and Bradley, S. E., *Proc. Soc. Exp. Biol.*, 53, 30 (1943).
[3] Winton, F. R., and Bayliss, L. E., "Human Physiology" (London, 1936).
[4] Heatley, N. G., *Biochem. J.*, 38, 61 (1944).

## Ammonia Excretion and the Clearance of Mepacrine

It has been found that the urinary excretion of mepacrine has a relation to the excretion of ammonia. The simplest description of this empirical relation is that the mepacrine clearance from the plasma is directly proportional to the rate of excretion of ammonia. This may be expressed thus:

$$\frac{UM \times V}{PM} = k\, UNH_3 \times V, \quad . \quad . \quad . \quad (1)$$

where $UM$ is urinary mepacrine in micrograms/litre; $V$ is volume of urine in ml./min.; $PM$ is plasma mepacrine in micrograms/litre; $UNH_3$ is urinary ammonia in mgm. $NH_3$-N/100 ml.; and $k$ a constant equal to 2·4.

Equation (1) may be written in the form:

$$PM = \frac{1}{k}\,\frac{UM}{UNH_3} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

In this form the relation can be used to estimate plasma mepacrine concentration from the urinary concentration of mepacrine and ammonia only, without regard to their rates of excretion. The relation has been studied and found to hold between the following limits: $UM$ from 260 to 4,900 micrograms/litre; $V$ from 1 to 10 ml./min.; $PM$ from 12·2 to 40·2 micrograms/litre; $UNH_3$ from 3·4 to 59·5 mgm. $NH_3$-N/100 ml.

The accompanying table shows the plasma mepacrine concentrations ($PM$ calc.), calculated from equation (2) for two separate urine samples obtained from each of ten subjects, compared with the plasma mepacrine concentrations directly determined by Masen's method[1] on blood samples drawn in the middle of each urine-collecting period ($PM$ obs.).

OBSERVED PLASMA MEPACRINE CONCENTRATION ($PM$ OBS.) COMPARED WITH THE CALCULATED VALUE ($PM$ CALC.).

| Volunteer No. | Period | $PM$ (obs.) microgram/litre | $PM$ (calc.) microgram/litre |
|---|---|---|---|
| 1 | I | 40·2 | 38·2 |
| | II | 32·8 | 41·8 |
| 2 | I | 32·3 | 33·8 |
| | II | 29·3 | 33·4 |
| 3 | I | 28·5 | 25·8 |
| | II | 26·6 | 22·7 |
| 4 | I | 25·4 | 26·2 |
| | II | 25·0 | 24·6 |
| 5 | I | 23·8 | 16·2 |
| | II | 23·0 | 24·6 |
| 6 | I | 19·9 | 30·6 |
| | II | 18·4 | 14·5 |
| 7 | I | 18·2 | 19·4 |
| | II | 17·4 | 16·1 |
| 8 | I | 16·3 | 14·6 |
| | II | 15·8 | 17·4 |
| 9 | I | 14·3 | 13·7 |
| | II | 13·9 | 14·6 |
| 10 | I | 13·0 | 14·6 |
| | II | 12·2 | 14·0 |

The standard deviation of the differences between $PM$ (obs.) and $PM$ (calc.) was found to be $\pm$ 4·0 micrograms per litre, with a mean plasma concentration of 22·2 micrograms per litre, whereas the standard deviation of $PM$ (obs.) (mean of triplicates) was itself $\pm$ 3·5 micrograms per litre.

The striking relation expressed in equation (1) has, so far as we know, not previously been reported. There is no reason to suppose that this relation is confined to the excretion of mepacrine. It possibly depends on the fact that mepacrine may behave like a substituted ammonia compound, in which case the relation may be applicable to the excretion of other such compounds.

For example, the observations by Haag *et al.*[2] that quinine is excreted more rapidly in acid urine than in alkaline suggests that this drug behaves like mepacrine. This possibility is being investigated.

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[1] Masen, J. M., *J. Biol. Chem.*, **148**, 529 (1943).
[2] Haag, H. B., Larson, P. S., and Schwartz, J. J., *J. Pharm. Exp. Ther.*, **79**, 136 (1943).

## Viscero-Motor Reflexes

STIMULATION of the sensory nerves of the abdominal viscera has given mixed results in the hands of different observers. Miller and his colleagues[1,2] obtained movements of the hind legs and belly muscles on centripetal stimulation of the mesenteric nerves of decapitated cats. Squeezing the intestine and traction on the mesentery were also effective. Lewis and Kellgren[3], on the other hand, obtained no movement of the legs or belly muscles on pinching the duodenum, but did record a rise of blood pressure. Pinching the pancreas caused both muscle movements and rise of blood pressure. McDowall[4], in 1942, stated that occlusion of the carotid and vertebral arteries of a decerebrated cat produces a 'spinal' preparation devoid of shock, and that certain stimuli, such as stretching the gut, cause marked limb movements. He pointed out that a successful result is obtained only if the preparation is not over-ventilated.

We also find that the presence or absence of spinal reflex movements following stimulation of the intestine depends on the preparation of the animal. When the brain of the cat is destroyed above the second cervical vertebra, no, or only very small, movements of the hind limbs follow a strong pinch of the duodenum, but a pinch of a small part of the head of the pancreas causes strong movements; a rise of blood pressure follows each pinch. This confirms the findings of Lewis and Kellgren. On the other hand, when the spinal cord is transected in the upper thoracic region and the cat then decerebrated, a gentle squeeze of any part of the small and large intestine causes strong movements of the hind legs. Other effective stimuli include scraping or scratching the serous coat or heating the gut, and also pulling or rubbing the mesentery. We find that the small intestine is less sensitive along its free border than near the attachment of the mesentery. Responses follow mechanical or thermal stimulation of an adequate area of the gut or repeated stimulation of a smaller area. All stimuli have been applied to the outside of the intestine, and it is not yet possible to define the site of origin of the afferent impulses.

When the response to visceral stimulation is tested some three hours after the operation under ether anæsthesia, superficial and deep reflexes of the hind legs are very lively and easily elicited in both preparations. It is curious that there is so little correspondence between the general reflex activity of the hind limbs and the responses to visceral stimulation. The viscero-motor responses may deteriorate to extinction without apparent change in the general reflex activity of the limbs. It must be recalled that

the animal with the head pithed is maintained alive by artificial respiration, and it is possible that the failure to elicit viscero-motor responses is related to the abnormal ventilation.

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[1] Miller, F. R., and Simpson, H. M., *Trans. Roy. Soc. Canada*, Sec. V, 18, 147 (1924).
[2] Miller, F. R., and Waud, R. A., *Amer. J. Physiol.*, 73, 329 (1925).
[3] Lewis, T., and Kellgren, J. H., *Clin. Sci.*, 4, 47 (1939).
[4] McDowall, R. J. S., *J. Physiol.*, 101, 6P (1942).

## Role of Acetylcholine and Vitamin $B_1$ in Nervous Excitation

A YEAR ago a short report of our work under the same title was given in *Nature*[1]. Since then new data have become available, which will be summarized briefly.

Stimulation of the branch of the vagosympaticus supplying the heart of the frog leads to the liberation of a second substance, besides acetylcholine, which diffuses into the fluid in the canula on which the heart is fixed. We have identified this substance as aneurin (thiamin) or an aneurin-compound[2]. Heart-fluids collected during resting periods do not contain the substance. Stimulation of the sympathetic component alone (nn. accelerantes) has no effect on the liberation of the substance. The result of stimulation of the mixed nerve varies from individual to individual. Pure vagus stimulation can be produced from the medulla oblongata. Stimulation with a special electrode produced in the heart more of the substance than is found otherwise. Oxidation with potassium ferricyanide in alkali transforms the substance into thiochrome, soluble in butanol, with the characteristic fluorescence of thiochrome. Ultra-violet of short wave-length (less than 290 mμ) destroys aneurin in solutions[3], *in vivo* in the nerve[4], and the same was found with the substance in heart-fluids collected during stimulation periods.

The amount of aneurin or aneurin-compound set free on vagus-stimulation was determined by two independent methods: (*a*) with our very sensitive fluorometer, making use of monochromatic illumination and a vacuum photocell, connected with a specially balanced amplifier[5]. After a total of five minutes stimulation (with intervals) of the vagus, $1 \times 10^{-8}$ gm. aneurin was liberated in each cm.$^3$ of heart fluid. (*b*) Growing *Phycomyces blakesleeanus* on heart fluids obtained during stimulation periods produced good growth. Fluids from resting periods of equal duration gave no or only negligible growth. Calibrating the growth-curves with aneurin solutions gave about the same amount of aneurin liberated during stimulation as with the thiochrome method. We cannot say at the moment if it is free aneurin or a compound of aneurin; aneurindiphosphate (cocarboxylase) is excluded.

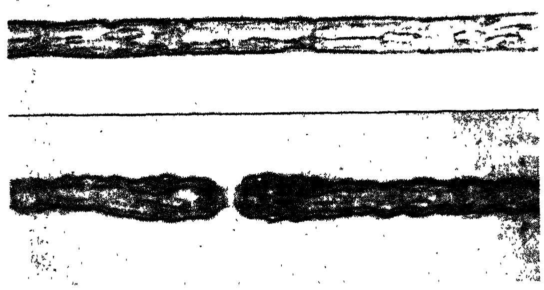
Adrenalin shows fluorescence on addition of alkali, an optical effect which might introduce an error; but it is insoluble in butanol in those concentrations which might interfere, and the fluorescence of the substance in our experiments is only produced by the addition of potassium ferricyanide. Interaction of adrenalin is ruled out by these chemical facts and by the biological observation that stimulation of the sympathetic chain does not produce a liberation of a substance with the same optical properties as the substance found on vagus stimulation.

Polarographic records were taken from heart fluids collected from resting periods, sympathetic stimulation and vagus stimulation. The 'vagus fluids' showed a regular and very considerable increase of the characteristic step in the polarogram near 1,950 mV. This effect corresponds exactly to the effect which was discovered two years ago[6] taking the polarogram of extracts from nerves, frozen in the excited state in liquid air, and to the effect obtained upon stimulation from the cut end of cholinergic nerves dipping into Ringer solution. 'Vagus fluids' from a stimulated heart, extracts of stimulated cholinergic nerves and solutions used for bathing stimulated nerves all show the same polarographic effect. The increase cannot be due to the liberation of free aneurin, the lowest concentration of chemical pure aneurin detectable by polarographic analysis being $1 \times 10^{-5}$. The aneurin liberated on stimulation in the cholinergic nerve and at the end of the vagus in the heart is an active compound with a strong catalytic effect on the dropping mercury electrode at 1,950 mV. At the same time, this compound has the same effect as vitamin $B_1$ on *Phycomyces blakesleeanus* and yields thiochrome on oxidation. The artificial aneurin compounds so far studied did not satisfy these three requirements at the same time. The aneurin compound set free in the heart on vagus stimulation must be considered as a special form of aneurin.

Löwi called the substance (acetylcholine) liberated on vagus stimulation in the heart "Vagusstoff", so long as he was not sure of its exact chemical nature. We propose to call the second substance which is liberated together with acetylcholine and which has the properties of an aneurin compound, "2. *Vagusstoff*".

The normal polarographic technique requires several minutes in order to take one record. This was not satisfactory in the study of the time relation between stimulation and appearance of the active aneurin compound in the bathing fluid into which the cut end of a stimulated nerve was dipping. We designed, therefore, a new apparatus in which the polarogram appears on the screen of a cathode ray oscillograph. With this apparatus the whole effect is visible as soon as the substances reach the dropping mercury electrode. Varying the distance between the cut end of the nerve and the dropping mercury electrode and taking the nerve out of the fluid at the end of the stimulation showed that the active substance is produced at the moment, or a few milliseconds later, when the excitation wave reaches the cut end of the nerve. Even if the liberation of this aneurin compound is connected with recovery from excitation in nerve, as we think to-day, the time relations between excitation, liberation of the substance and recovery are very short.

Ultra-violet photomicrographs of living single nerve fibres (nerve-muscle preparation) have been taken with $\lambda = 280$, 275 and 257 mμ. The accompanying photomicrographs reveal the existence *in vivo* of the protoplasmic marginal net, described by Cajal and Nageotte on fixed preparations, and the extensive development of this net on the node. Taking the ultra-violet absorption spectrum of *living* nerve fibres with an apparatus designed very much along the lines developed by Caspersson[7], a distinct maximum of absorption was found at $\lambda = 265$ mμ. It corresponds to the maximum of absorption of aneurin. This maximum disappeared after treating the fibres with potassium ferricyanide. The disappearance on chemical treatment confirms this view, because this



ABOVE, LIVING SINGLE NERVE FIBRE OF FROG. CADMIUM SPARK, $\lambda = 275$ m$\mu$, QUARTZ CONDENSER AND CORRECTED QUARTZ OBJECTIVE AND OCULAR. SIZE OF FIBRE DIAMETER, 8 $\mu$.

BELOW, NODE OF RANVIER, DIED DURING EXPOSURE (1 MIN.), SAME TECHNIQUE AS UPPER PHOTOMICROGRAPH.

substance is transformed into thiochrome in nerve as was shown previously[8], and then the maximum shifts to 375 m$\mu$. The measurements are complicated by the photochemical action of the short-wave ultra-violet on the single nerve fibre[4]. This action is immediate at the nodes of Ranvier; the internodal section is protected by the nerve sheath. The photochemical decomposition of the sheath can be followed by serial photographs. In one series, by chance one photograph was taken just before the last excitation wave passed the single fibre and the next photograph was taken one second after impairment of conduction. Impairment of conduction was due to disconnexion of the axis cylinder produced by ultra-violet radiation (275 m$\mu$), clearly visible on the photomicrograph.

The acetylcholine and aneurin content was measured in mammalian nerve fibres during Wallerian degeneration. Acetylcholine disappears very rapidly after section of the nerve, as previously found by other authors[9]. In our experiments the ability of nerve to synthesize acetylcholine was maintained so long as the nerve remained excitable. Aneurin has quite a different curve. The loss is great in the first twenty-four hours and slows up from then on, so that a certain level is maintained even after seventy-two hours of degeneration. Protracted degeneration was observed after the administration of aneurin, using as a test the degeneration of the nerve fibres in the cornea of the rabbit, visible with a special slit-lamp and vital staining method.

The experiments reported confirm the conception that acetylcholine formation is essential for the excitation or recovery process and that aneurin is a reservoir substance closely connected with the formation and disappearance of acetylcholine[10].

Full details will be presented elsewhere. I am indebted to the Rockefeller Foundation for grants in aid of this work.

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[1] v. Muralt, *Nature*, **152**, 188 (1943).
[2] Wyss and v. Muralt, *Helv. Physiol. Acta*, in the Press.
[3] Uber and Verbrugge, *J. Biol. Chem.*, **134**, 273; **136**, 197 (1935).
[4] Stämpfli, dissertation, Berne (1942). Hutton-Rudolph, *Helv. Physiol. Acta*, **1**, C 15 (1943). Hutton-Rudolph, dissertation, Berne (1944).
[5] Wyss, *Helv. Physiol. Acta*, **1**, C 70 (1943).
[6] v. Muralt, *Pflügers Arch.*, **245**, 604 (1942).
[7] Caspersson, *J. Roy. Micro. Soc.*, **60**, 8 (1940).
[8] v. Muralt, *Pflügers Arch.*, **247**, 1 (1943).
[9] cf. Feldberg, *J. Physiol.*, **101**, 432 (1943).
[10] cf. v. Muralt, *Schweiz. Med. Wschr.*, **73**, 1101 (1943); **74**, 643 (1944).

## Metabolism of Symmetrical Trinitrotoluene

THE recent publication by Channon *et al.*[1] of a paper on the T.N.T. metabolism in the rabbit induces us to record similar investigations carried out during the past two years with rats, human volunteers and munition workers.

For the estimation of diazotizable amines a spectrophotometric method, based on the principles of the method of Bratton and Marshall[2] for sulphonamides, was used. A simplified colorimetric method was made available to the Commonwealth Department of Health in June 1943.

The excretion of diazotizable amines was found to be roughly proportional to the intake of T.N.T. In the rat the recovery (15–20 per cent of ingested T.N.T.) was lower than found by Channon *et al.* with the rabbit, while on the average 40 per cent of small doses (10–30 mgm.) given to human volunteers was excreted in this form.

The reduction products in the urine were separated as follows: after acid hydrolysis (one hour in 1/8 $N$ hydrochloric acid) the acid urine was extracted with ether in a continuous extraction apparatus giving Extract I. The residual urine was then neutralized with sodium carbonate and the more strongly basic compounds extracted with ether in the same manner (Extract II). Both ether extracts were washed with sodium bicarbonate, afterwards with sodium hydroxide. The sodium hydroxide extracts contained much more diazotizable amino-compounds than the bicarbonate extracts, the substances extracted evidently being amino-nitrocresols. The weakly basic dinitrotoluidines were extracted from the first ether extract with 20 per cent and concentrated hydrochloric acid, the strongly basic nitrotoluylene diamines from the second extract with 1 per cent hydrochloric acid. 4-amino-2.6-dinitrotoluene and 2.4-diamino-6-nitrotoluene added to normal rats' urine could be recovered quantitatively by this procedure, the former in the first, the latter in the second extract.

The ether-extractable pigments of munition workers' urine consisted of 60–75 per cent dinitrotoluidines, 10–25 per cent nitrotoluylene diamines and 10–15 per cent of amino-nitrocresols. In the rat the results were, however, different: nitrotoluylene diamines predominated (50–60 per cent), while dinitrotoluidines and amino-nitrocresols formed the remainder in about equal proportion.

From the human dinitroluidine fraction we isolated 4-amino-2.6-dinitrotoluene (m.p. 175°, no m.p. depression with pure compound m.p. 175°) and a product with melting points varying between 128° and 136°, more lightly coloured than the 4-amino-compound, less basic and extracted from ether fully only by concentrated hydrochloric acid. Acetylation with pyridine-acetic anhydride revealed that the latter was still a mixture; the acetyl compound consisted of flat square-ended yellow needles and some fine colourless needles. The greater part melted at 159°, but a small part remained solid up to 196°. Since the acetyl compound of 6-amino-2.4-dinitrotoluene forms yellow needles, melting at 159–160° (Channon *et al.*[1]), while that of the 4-amino-compound crystallizes in almost colourless needles of m.p. 227°, the product was evidently the 6-amino-compound with some 4-amino-compound admixed. The Webster test, which we carry out in alcohol-ether mixture 1 : 1, adding small amounts of alcoholic potash, gave with ether extracts of human urines the brownish-purple colour

indicated the presence of 4-hydroxylamino-2.6-dinitrotoluene. The products present in the human urines are thus mainly the same found by Channon *et al.* in the rabbit.

In the dinitrotoluidine fraction from the rat we found only 4-amino-2.6-dinitrotoluene. The nitrotoluylene diamine fraction gave a compound very similar in properties to 2.4-diamino-6-nitrotoluene. It was less soluble than the latter in chloroform and crystallized in orange needles of m.p. 145° which gave a large melting-point depression with pure 2.4-diamino-6-nitrotoluene of m.p. 138°. The acetyl compound crystallized in deep yellow triangles or twinned prisms, m.p. 336°. The assumption that this compound is the isomeride (2.6-diamino-4-nitrotoluene) was ruled out by the observation that it can be obtained in good yield by feeding 2.4-diamino-6-nitrotoluene to rats. Analyses have shown that the substance is 5-nitro-*m*-phenylene diamine, for which Flürscheim[3] reported m.p. 141°. The rat is thus able to remove the methyl group from T.N.T. The mother liquors contained 2.4-diamino-6-nitrotoluene.

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[1] Channon, H. J., Mills, G. T., and Williams, R. T., *Biochem. J.*, **38**, 70 (1944).
[2] Bratton, A. C., and Marshall, E. K., jun., *J. Biol. Chem.*, **128**, 537 (1939).
[3] Flürscheim, *J. prakt. Chem.*, **71**, 538 (1905).

## Specific Protective Influence of Alanine in Differential Tissue Destruction by Hexenolactone (Parasorbic Acid)

MEDAWAR'S differential 'mesoderm inhibitor', originally obtained from malt, ungerminated grain and oranges, has been closely reproduced through synthesis by Medawar, Robinson and Robinson[1], who are not entirely certain whether their malt-distillate factor is optically active δ-hexenolactone or an allied substance. Because of structural similarity with panto-lactone, which combines with β-alanine to form pantothenic acid, synthetic *dl*-δ-$\Delta^{\alpha\beta}$ hexenolactone and its natural equivalent (probably parasorbic acid) were suspected of entering somehow into pantothenic acid metabolism, possibly by competition with panto-lactone.

Kuhn and Jerchel[2], independently of Medawar *et al.* and following a different procedure, also prepared an optically inactive unsaturated δ-hexenolactone and established its structural identity with parasorbic acid. Kuhn, Jerchel, Moewus, Moller and Lettre[3] confirmed the differential inhibition of fibroblasts at concentrations of this lactone which did not affect neoplastic epithelium, and found that addition of excess pantothenic acid did not interfere with inhibition. Similar negative results with pantothenic acid were obtained in this laboratory.

To elucidate the tissue-differential effect of hexenolactone with respect to a possible mechanism involving alanine, several aquatic invertebrates were tested in media containing α-alanine, β-alanine, glycine, *iso*-leucine, *d*-glutamic acid or glutathione in addition to *M*/20,000 hexenolactone (that is, 0·0056 mgm./c.c. or one half the concentration needed to inhibit chick fibroblasts). Carefully matched control animals were cultured simultaneously in *M*/20,000 hexenolactone alone. The lactone was synthesized by McNeil Laboratories according to the method of Kuhn and Jerchel[2].

Best results were obtained with the flatworm *Dugesia tigrina*, which responds by developing a three-branched, *Y*-shaped lesion in the dorsal wall. The lesion corresponds in pattern to the triclad intestine. Extent of lesion is directly correlated with state of nutrition, being greatest in well-fed animals, regardless of body size.

The inhibitor, therefore, appears to take effect from within the animal, producing first a partial evisceration; secondly, disintegration of gut and surrounding mesenchyme; and lastly, the lesion in the dorsal epithelium. There is no antero-posterior susceptibility gradient, but a tissue-differential response. Measurements on lesion area, survival and extent of healing permit quantitative comparison between tests and controls. The following results represent percentage differences in lesion area, based on fifty-two separate experiments with a total of 2,010 specimens of *Dugesia tigrina*:

| | | | |
|---|---|---|---|
| | — 67·5 | per cent. | β-alanine *M*/40,000 |
| Protection | — 61·9 | ,, ,, | Glutathione *M*/50,000 (thio-alanine) |
| (reduced | — 46·8 | ,, ,, | β-alanine *M*/20,000 |
| lesion area) | — 46·3 | ,, ,, | Glutathione *M*/20,000 (thio-alanine) |
| | — 5·8 | ,, ,, | β-alanine *M*/5,000 |
| | + 2·4 | per cent. | *Iso*-leucine *M*/20.000 |
| No protection | + 18·6 | ,, ,, | *Iso*-leucine *M*/50,000 |
| (increased | + 29·6 | ,, ,, | Glycine *M*/40,000 |
| lesion area) | + 33·0 | ,, ,, | Glycine *M*/100,000 |
| | + 34·5 | ,, ,, | Glutamic ac. *M*/50,000 (*p*H adjusted) |
| | + 96·4 | ,, ,, | Glutamic ac. *M*/50,000 (*p*H not adjusted) |

Data on survival and wound-healing were consistent with these results. Only alanine and glutathione (the cysteine component of which is actually thio-alanine) had a specific protective influence. α-Alanine, tested on the annelid *Dero limosa*, behaved similarly to β-alanine. Glycine, *iso*-leucine and *d*-glutamic acid did not counteract the inhibitor but actually added to its toxicity.

Even the alanines ceased to give protection against *M*/20,000 hexenolactone at concentrations above *M*/5,000, although *M*/1,000 α- and β-alanine as such had no visible toxic effect. This seeming inconsistency with regard to concentration was obtained consistently not only with the alanines, but also with glutathione. Apparently the protective behaviour is confined to an optimum concentration within relatively narrow limits.

Since pantothenic acid does not interfere with the activity of hexenolactone, while α-alanine, β-alanine and glutathione (thio-alanine) do so, a specific alanine mechanism distinct from the alanine link in the biosynthesis of pantothenic acid is very probably at work in differential inhibition and differential tissue destruction by hexenolactone.

Mendez[4], studying digitalis- and angelica-lactones, found their cardiac activity dependent on peroxides formed in aqueous solution in the presence of metallic impurities. If the hexenolactone effect were likewise due to peroxide, protection by glutathione is feasible on the basis of a reaction between SH and $H_2O_2$. On the other hand, it is not clearly understood how alanine might behave toward peroxide, unless it gives rise to pyruvate upon oxidative deamination. If so, why should the hypothetical reactivity between alanine and peroxide decrease with a slight increase in the concentration of the former?

In view of the wide occurrence of simple unsaturated lactones and their probable function as natural

inhibitors, further work on their role in developmental and neoplastic growth should prove fruitful.

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[1] Medawar, P. B., Robinson, G. M., and Robinson, R., *Nature*, **151**, 195 (1943).

[2] Kuhn, R., and Jerchel, D., *Ber. Chem. Ges.*, **76** B, 413 (1943).

[3] Kuhn, R., Jerchel, D., Moewus, F., Moller, E. F., and Lettre, H., *Naturwiss.*, **31**, 468 (1943).

[4] Mendez, R., *J. Pharmacol. and Exper. Therap.*, **81**, 151 (1944).

## Absolute Photopic Sensitivity of the Eye in the Ultra-violet and in the Visible Spectrum

IN a paper published in 1941[1], measurements of photopic and scotopic sensitivity were given; nine observers were used, after one hour adaptation to the dark, according to the method of colour appearance. These measurements were made in the range between the mercury lines 709 and 302 mμ. In this paper I am considering the question of absolute photopic sensitivity, as the inverse of the illumination of the retina $P_\lambda = 1/J_\lambda$.

The absolute photopic sensitivity, $P_\lambda$, in terms of number of (quanta/sec. sq. mm.)$^{-1}$ is related to the illumination of the pupil $E_\lambda$ (the latter being expressed in erg./sec. sq. cm.) by the equation

$$P_\lambda = \left[\frac{E_\lambda \times 10^{-2}}{h\nu} \cdot (1 - r) \cdot \frac{\sigma}{a}\right]^{-1},$$

where $r$ represents the reflexion losses at the cornea (assumed to be 0·05), $\sigma$ the area of the pupil (assumed to be 0·33 cm.$^2$) and $a$ the area of the image on the retina. The area of the image $a$ was 0·0083 mm.$^2$.

THE ILLUMINATION OF THE PUPIL, THE RETINAL ILLUMINATION AND THE ABSOLUTE PHOTOPIC SENSITIVITY OF THE NORMAL EYE IN THE ULTRA-VIOLET AND IN THE VISIBLE SPECTRUM (AVERAGE VALUES FOR 9 OBSERVERS).

| $\lambda$ mμ | $E_\lambda \frac{\text{erg}}{\text{sec. cm.}^2}$ | $P_\lambda \left(\frac{\text{quanta}}{\text{sec. mm.}^2}\right)^{-1}$ | Log $P_\lambda$ |
|---|---|---|---|
| 302 | $8 \cdot 47 \times 10^{-1}$ | $2 \cdot 16 \times 10^{-12}$ | −12·7 |
| 313 | $8 \cdot 86 \times 10^{-2}$ | $1 \cdot 87 \times 10^{-12}$ | −11·7 |
| 334 | $2 \cdot 13 \times 10^{-2}$ | $7 \cdot 75 \times 10^{-12}$ | −11·1 |
| 365 | $6 \cdot 69 \times 10^{-3}$ | $2 \cdot 25 \times 10^{-11}$ | −10·6 |
| 390 | $6 \cdot 84 \times 10^{-4}$ | $2 \cdot 10 \times 10^{-10}$ | − 9·7 |
| 404–407 | $1 \cdot 36 \times 10^{-4}$ | $1 \times 10^{-9}$ | − 9·0 |
| 435 | $1 \cdot 88 \times 10^{-5}$ | $6 \cdot 71 \times 10^{-9}$ | − 8·2 |
| 491 | $3 \cdot 35 \times 10^{-6}$ | $3 \cdot 34 \times 10^{-8}$ | − 7·5 |
| 546 | $1 \cdot 34 \times 10^{-6}$ | $7 \cdot 52 \times 10^{-8}$ | − 7·1 |
| 576–579 | $2 \cdot 74 \times 10^{-6}$ | $3 \cdot 47 \times 10^{-8}$ | − 7·5 |
| 690–709 | $4 \cdot 91 \times 10^{-4}$ | $1 \cdot 60 \times 10^{-10}$ | − 9·8 |

The accompanying table shows the results of my measurements of photopic sensitivity. The curve of photopic sensitivity has its maximum at about 546 mμ. A more exact determination of the maximum does not appear to be obtainable, as the mercury spectrum has no corresponding lines. In my paper[1] it is stated: "the chromatic sensitivity decreases regularly with the decrease of the wavelength to 302 mμ". Speaking strictly, the photopic sensitivity curve in the 365–334 mμ region has a small but still visible flattening, after which it drops abruptly again.

The *scotopic* sensitivity in this region has its maximum (in the case of some observers) or a pronounced flattening of the curve (in other cases). Apparently some maximum of transmission in the lens occurs in the region of 365–334 mμ.

Measurements of the photopic sensitivity curve in the ultra-violet were made by C. F. Goodeve (unpublished). These measurements clearly show a marked flattening of the curve and a point of inflexion at about 350 mμ.

Our results as concerns the character of the curve in the ultra-violet thus confirm the work of Goodeve *et al.*[2].

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[1] Pinegin, N. I., *C.R. Acad. Sci. URSS.*, **30**, 3 (1941).

[2] Goodeve, C. F., Lythgoe, R. J., and Schneider, E. E., *Proc. Roy. Soc.*, B, **130**, 392 (1942).

## New Light on the Mammalian Ear Ossicles

IN spite of many criticisms, the Reichert-Gaupp theory of the mammalian ear ossicles[1,2,3,4] has, in its main points, been confirmed by a considerable body of work on the developmental anatomy of recent mammals and reptiles, and on the structure of therapsid reptiles. There can be little question that the stapes, incus and malleus (except for its dermal component, the goniale of Gaupp) are essentially homologous respectively with the reptilian columella auris (proximal part or otostapes), quadrate and articular. The existence of vestiges of other elements of the reptilian lower jaw and extrastapes in the mammalian middle ear has been suggested by numerous investigators. Thus the goniale is usually equated with the pre-articular[1,2,3,4, etc.], and the elements of Paauw and Spence have been regarded as parts of the extrastapes[5]. But in general there has been little agreement on the detailed homology of the parts of the stapes, of the crura of the incus, and of the various processes of the malleus; this is largely because most of our information on these points is based on the anatomy of adult and embryonic stages of living mammals and reptiles, while mammals originated from the extinct therapsid reptiles, which differ from Lacertilia and *Sphenodon* in important respects. Until recently, too little was known in detail about the middle ear and lower jaw of therapsids, though Broom[6] showed the position of the tympanic membrane and the presence of an ossified portion of the extrastapes in some Therocephalia (see also ref. 7). E. C. Olson[8] has now provided, among other interesting things, an account of the structure of the otic region of several therapsids (Anomodontia, Therocephalia, Gorgonopsia, Cynodontia) based on serial sections. The structure of the middle ear region is greatly illuminated by this work; but some of his conclusions seem to be open to question, while others can be further supported.

In all the forms discussed by Olson the stapes is perforate, and has a well-marked articulation with the quadrate (by a "processus internus" meeting a special extrastapedial process or lamina from the quadrate), and a strong process which is clearly the base of the distally cartilaginous extrastapes. A processus dorsalis and a separate hyoid process are not present in the fossils. The quadrate in all forms lies in a deep groove in the squamosal, but seems to have been attached to the squamosal and otic region by connective tissue and ligaments only. Valuable new details of the lower jaw are also provided by Olson's sections.

The stapes is exceedingly mammal-like in character: it might be added that a columelliform stapes is present in some therapsids as well as in the adults of some Marsupialia and the Monotremata. It seems highly probable that the stapedial muscle was inserted on the posterior part of the therapsid stapes, probably on the processus extrastapedialis. The

position and relationships of Paauw's cartilage[5] now show clearly that this element is homologous with the proximal part of the extrastapes, and the processus internus of the therapsid stapes is as clearly indicated as the homologue of the head of the mammalian stapes. Olson, following van der Klaauw[5], seeks the equivalent of the processus internus in Spence's cartilage, and is driven to the conclusion that the incudo-stapedial articulation in mammals has shifted proximally on the stapes. But the relationships of Paauw's cartilage show that the mammalian articulation is the primary one, and Spence's cartilage needs further consideration. If it is not a structure peculiar to mammals, it can only be regarded as the remains of the distal (tympanic) portion of the extrastapes. Its position in mammals is quite consonant with this interpretation, and with the views previously expressed[7] on the evolution of the mammalian middle ear. The recent suggestion of Findlay[9], that Spence's cartilage and the manubrium mallei together represent the distal part of the extrastapes, is improbable in view of the developmental evidence that the manubrium is part of the mandibular arch, and of the nature of the therapsid retro-articular process.

Olson also criticizes Gaupp's recognition[1] (now widely accepted) of the goniale (dermal part of the processus Folii or gracilis of the malleus) as the reptilian prearticular. On the basis of the position of the goniale, partly lateral to Meckel's cartilage in some forms, and of variations in the course of the chorda tympani in mammals, he suggests that the goniale and tympanic annulus *together* are equivalent to the reptilian angular. This suggestion receives further support from consideration of the effects of the inward rotation of the lower part of the tympanic ring in many mammals. The ossiculum accessorium malleoli of some mammals (not discussed by Olson) also helps to confirm Olson's views. This small element lies medial or dorso-medial to the goniale, with which it often fuses, and medial also to the chorda tympani. Older investigators (see van Kampen[10]) speak of this bone lying *above* Meckel's cartilage, and it was regarded as the surangular by Watson[11]. Broom[12] and Forster Cooper[13] held the same view about a similar ossicle in *Chrysochloris* which, however, lies ventro-medial to Meckel's cartilage. The last-mentioned ossicle is almost certainly the prearticular; that of many Ungulates is probably the same, and may owe its position to rotation of the malleus and neighbouring lower jaw elements. This region deserves further investigation.

It is hoped to present a fuller account of this subject, with comments on recent work, in another place.

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[1] Gaupp, E., *Arch. Anat. Physiol.*, I Teil (*Arch. Anat. Entw.-Gesch.*), Supp. Bd., 1 (1912).
[2] van der Klaauw, C. J., *Z. ges. Anat.*, I Teil (*Z. Anat. Entw.-Gesch.*), 69, 32 (1923).
[3] Goodrich, E. S., "Studies on the Structure and Development of Vertebrates" (London, 1930).
[4] de Beer, G. R., "The Development of the Vertebrate Skull" (Oxford, 1937).
[5] van der Klaauw, C. J., *Ergebn. Anat. Entw.-Gesch.*, 25, 565 (1924).
[6] Broom, R., *Phil. Trans.*, B, 226, 1 (1936), esp. pp. 23–4, 27, figs. 102, 103, 121.
[7] Westoll, T. S., *Proc. Roy. Soc.*, B, 131, 393 (1943).
[8] Olson, E. C., *Geol. Soc. Amer.*, Spec. Papers, No. 55 (1944).
[9] Findlay, G. H., *Proc. Zool. Soc. Lond.*, 114, 91 (1944).
[10] van Kampen, P. N., *Morph. Jahrb.*, 34, 321, 372 (1905).
[11] Watson, D. M. S., *Phil. Trans.*, B, 207, 311, 361 (1916).
[12] Broom, R., *Proc. Zool. Soc.*, 449, 454, 457, pl. 2, fig. 9 (1916).
[13] Forster Cooper, C., *Phil. Trans.*, B, 216, 265, 267, text-fig. 1 (1928).

## Control of Buried Viable Weed Seeds by Means of Boron

BORON compounds, when present in the soil in abnormal concentrations, are known to exert a highly toxic effect on the vegetation. The extent of the toxicity at given concentrations varies according to the component species present in the vegetation, and according to the nature and texture of the soil[1].

In the course of an investigation conducted at the Welsh Plant Breeding Station to study the growth of red clover on old grassland soils, it was revealed that an application of borax at the rate of 90 lb. per acre had an extremely toxic effect on the germination and establishment of the clover. The soil was a medium loam of average fertility, and had carried grass vegetation for many years. The soil samples were taken at a depth of 2–6 in. below the surface vegetation, and placed in wooden boxes 21 in. × 15 in. × 3 in. Each treatment was replicated twice.

As was expected, the control boxes showed that the soil contained a very large population of buried viable weed seeds (see table below), but where borax had been applied at the above rate, a practically weed-free surface was obtained. The few weeds that did appear in the treated boxes were largely confined to the corners and around the edges of the boxes, where the distribution of the borax had presumably not been quite uniform.

The accompanying table shows the germination and establishment of red clover (sown at the rate of 35 seeds per box) in the treated and untreated boxes. The establishment figures of viable weed seeds are also given.

| | Germination | | Establishment | |
|---|---|---|---|---|
| Seedlings | Treated | Untreated | Treated | Untreated |
| Clover | 10 | 29 | 7 | 28 |
| Weeds* | — | — | 15 | 137 |

* The establishment figures given bear no relation to total buried viable weed seed population, as they refer only to such seed as were sufficiently near the surface to give visible seedlings.

It was evident from the fact that the surface obtained in the treated boxes was practically free from weed and clover that the toxicity of the borax had effected a very heavy kill on both the clover and buried weed seeds prior to their becoming visible seedlings.

The duration of the toxicity due to boron was further investigated and the treated boxes were resown with red clover at the previous rate (35 seeds per box), 35 days from the application of the chemical. The germination was now even and vigorous, and 31 seeds out of 35 gave strong normal seedlings. The germination of weeds was very low—only 15 weed seedlings appeared, and that in spite of the fact that the soil had been completely overturned at re-sowing. This seems to indicate that the toxic effect had operated throughout the depth of the soil.

It is evident from these figures that the toxic effect had been practically removed after 35 days. No determination was made of the precise number of days after which germination gained normality. Further, as this experiment was conducted in boxes and under glass, it is not known whether the removal of toxicity would occur at the same rate under field conditions. Also it must be stated that the rate of application

is not suggested as optimum, and a higher or lower rate may be more efficacious.

The results given above were obtained as part of a more general investigation; a more detailed repetition of the section dealing with toxicity is intended, before precise practical application can be suggested. These results do, however, offer distinct possibilities of practical control for one of the most acute weed problems in agriculture.

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[1] See Robins, Crofts and Raynor, "Weed Control" (1942).

## Mechanism of the Milling Shrinkage of Wool Fabrics

THE work of Speakman[1] and his collaborators has indicated that the felting or milling shrinkage of wool fabrics is primarily due to the scaliness of the fibres, but that in cloths of similar construction and composition the magnitude of the effect is determined by the ease of extension and the power of recovery of the fibres. The shrinkage of fabrics milled under comparable conditions is greater in acid and alkaline solutions than in water, and cloths may be rendered unshrinkable by treatment with reagents such as chlorine[2], caustic soda[3] or sulphuryl chloride[4]. These phenomena may be due to modification of either elastic properties or scaliness, and the experiments described in this note were designed to determine which of the two characteristics was more affected. A complete account of the investigation will appear elsewhere, but its main features are as follows:

Measurements of the scaliness of wool fibres in acid (0·1 *N* hydrochloric acid), water, and 2 per cent borax solution (*p*H 9·24) were made by the violin bow method of Speakman and Stott[5], and the results are summarized in Table 1.

TABLE 1.

| Medium | Scaliness |
|---|---|
| 0·1 *N* hydrochloric acid .. .. | 29·4 |
| Water .. .. .. .. .. | 23·5 |
| 2 per cent borax solution .. .. | 21·5 |

The scaliness increases with decreasing *p*H, and hence scaliness changes act in unison with the reduced ease of extension to increase the rate of milling of fabrics in acid solutions. The reduced scaliness in alkaline solutions, however, acts in the opposite direction to the increased ease of extension, and the superior milling shrinkage in alkaline solutions of *p*H 9·24 must be due solely to increased ease of extension, which is not accompanied by a loss of power of recovery of the fibre.

The role of scaliness in determining the shrinking properties of wool fabrics has also been demonstrated by measuring the scaliness and elastic properties of wool fibres treated with a 0·2 *N* solution of chlorine in carbon tetrachloride for various times. Parallel experiments in which patterns of cloth were chlorinated under the same conditions, and then milled to measure their shrinkage, were also carried out. The results are shown in Table 2.

It is evident that the loss in milling shrinkage is mainly due to a reduced scaliness of the fibres, for there is little change in the elastic hysteresis, and the increased ease of extension would result in an increased shrinkage. Since cloths which have been chlorinated for two hours are completely unshrinkable when milled in acid or soap, it appears to be unnecessary to reduce the scaliness of the fibres to zero in order to realize unshrinkability. Similar results have also been obtained on cloths and fibres treated with other reagents which render wool cloths unshrinkable. Whereas the scaliness, as measured by the percentage difference in friction, is reduced by chlorination, the actual values of the angles of friction increase, indicating greater adhesion between the fibres and the surface over which they slip. This increased adhesion is reflected in the greater strength of chlorinated yarns, for since the strength of individual fibres falls on chlorination, the superior yarn strength must arise from an increased adhesion between the fibres.

TABLE 2.

| Time of treatment (hr.) | % shrinkage after milling for 30 min. | % reduction in work to stretch in | | | % Elastic hysteresis in | | | (iii) Scaliness in | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Water (i) | 0·1 *N* hydrochloric acid (ii) | 2% borax (ii) | Water | 0·1 *N* hydrochloric acid | 2% borax | Air | Water | 0·1 *N* hydrochloric acid | 2% borax |
| 0·0 | 35·0 | 2·7 | 38·0 | 0·8 | 53·5 | 40·0 | 62·2 | 15·8 | 23·5 | 29·4 | 21·5 |
| 0·5 | 7·9 | 9·9 | 40·8 | 15·0 | 54·9 | 41·2 | 62·2 | 12·0 | 7·9 | 17·1 | 10·6 |
| 1·0 | 5·0 | 12·0 | 39·2 | 18·5 | 54·9 | 40·2 | 62·4 | 7·4 | 4·1 | 9·8 | 6·0 |
| 2·0 | 0·6 | 15·8 | 41·5 | 19·1 | 56·1 | 41·5 | 62·1 | 5·0 | 1·5 | 7·2 | 5·3 |
| 3·0 | −4·0 | — | — | — | — | — | — | — | — | — | — |
| 5·0 | — | 17·6 | 41·8 | 22·5 | 54·6 | 42·4 | 61·8 | 4·0 | 1·0 | 6·0 | 3·5 |

(i) Calculated as a percentage of the work required to stretch an untreated fibre in water.
(ii) Calculated as a percentage of the work required to stretch a chlorinated fibre in water.
(iii) Calculated as described by Speakman and Stott[5].

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[1] *J. Text. Inst.*, **24**, 273T (1933).
[2] Brit. Pat. 417,719.
[3] Brit. Pat. 538,428; 538,396.
[4] Hall, *J. Soc. Dyers and Col.*, **55**, 389 (1939).
[5] *J. Text. Inst.*, **22**, 339T (1931).

## Halogenation in the Allyl Position

IN the last issue of the "Annual Reports of the Chemical Society"[1], F. S. Spring has directed special attention to the success of Ziegler and his collaborators[2] in substituting olefines in the α-methylene, or 'allyl position', by means of N-bromo-succinimide, and it has been claimed that this is a new reaction.

Whereas from the preparative aspect N-bromo-succinimide is obviously a valuable new reagent, halogen substitution in the α-methylene position to a double bond is but to be expected if the reaction is of the 'free radical' or 'atomic' type, as shown recently by E. H. Farmer and his colleagues[3].

The 'atomic' chlorination of *cyclo*-hexene to $\Delta^2$*cyclo*-hexenyl chloride by benzene diazonium chloride was reported by me in 1939[4], and in 1937 I had suggested tentatively that compounds containing the so-called 'positive halogens', as, for example, the N-halogeno-imides, were molecules which underwent neutral or 'atomic' bond fission in preference to ionic bond fission[5]. The work of Ziegler should be regarded as a definite confirmation of this hypothesis.

Reaction mechanisms involving the neutral bond fission of 'positive halogen' compounds should, however, be applied with caution, since chemical changes of this type are in general chain processes very much dependent for their success on the concentrations and energy-levels of the transient radicals[6], and on the non-polar character of the solvent used. Thus Kharasch and Priestley[7] have reported the occurrence of two distinct types of addition reactions between N-halogeno-imides and olefines, and the regular use by Ziegler of carbon tetrachloride as solvent may well be an essential factor in contributing to the success of the α-methylenic substitution[6].

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[1] "Annual Reports of the Chemical Society", **40**, 101 (1943).
[2] *Annalen der Chemie*, **551**, 80 (1942).
[3] *Trans. Faraday Soc.*, **38**, 340 (1942).
[4] *J. Chem. Soc.*, 1805 (1939).
[5] *J. Chem. Soc.*, 2007 (1937).
[6] Waters, *Trans. Faraday Soc.*, **37**, 770 (1941).
[7] *J. Amer. Chem. Soc.*, **61**, 3425 (1939).

## A Colour Reaction for Aromatic Amidines

Ekeley and Ronzio[1] have described a series of coloured compounds which are obtained when aromatic amidines are heated with glyoxal in alkaline solution. The reaction is complex, and the results are uncertain and dependent on the conditions employed. By heating with a very small amount of glyoxal at *p*H 9 in the presence of a borate buffer, the reaction is made much more sensitive and reliable, and is suitable for the quantitative estimation of amidines down to 1 in 100,000[2]. The buffer is made up from 4 gm. of boric acid neutralized in hot solution with caustic soda to *p*H 9, and diluted to 100 ml. The glyoxal reagent is a 0·5 per cent aqueous solution of glyoxal sodium bisulphite.

To a few millilitres of the suspected amidine solution (containing a few milligrams of amidine and roughly neutralized if necessary) is added about a millilitre each of buffer and glyoxal reagent, and the mixture is heated almost to boiling for a few minutes, or for ten minutes in a boiling water bath. A pink or magenta colour appears, which usually becomes redder in acid and bluer in alkaline solution. Maximum colour is obtained with about two molecules to one of amidine, and excess of glyoxal inhibits the reaction.

The reaction appears to be sharply specific for an unsubstituted aromatic amidine group. It is given by C-substituted benzamidines, naphthalene diamidine and nicotinamidine. Nearly fifty aromatic amidines have been tested and found to give the reaction. It is not given by aromatic amidines with one or two methyl groups on the nitrogen atoms of the amidine group. Benzamidrazone and phenyl acetamidine give a pale yellow colour. Guanidines, biguanides, amines or aliphatic amidines do not react.

The reaction products from some aromatic amidines fluoresce in ultra-violet light down to dilutions of 1 in 100 millions. Those from the diamidine series (for example, propamidine) are sparingly soluble, show no colour change with variation of *p*H, and do not fluoresce.

When the method had been in use for some time, Devine[3] published a process of estimation using the brown colour produced when an amidine is heated with a large excess of glyoxal in strong caustic soda. This has the disadvantages that the glyoxal reagent is unstable and must be made up daily; that the conditions of heating are difficult to reproduce exactly; and that the colour is unstable and must be estimated immediately. It is, however, not so sensitive to variations in the amount of glyoxal used as is the present method.

I wish to thank Dr. H. King and Dr. J. Walker for supplying the compounds.

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[1] Ekeley, J. B., and Ronzio, A. R., *J. Amer. Chem. Soc.*, **57**, 1353 (1935).
[2] Evans, D. G., Fuller, A. T., and Walker, J., *Lancet*, ii, 523 (1944).
[3] Devine, J., *Ann. Trop. Med. and Parasitol.*, **38**, 35 (1944).

## David Forbes and Guano Archæology

In a footnote to a brief communication made by Virchow in 1873[1] is a statement transmitted to him through Jagor and A. W. Franks, which seems to imply that David Forbes, the well-known geologist, owned or knew of wooden statuettes taken from the guano deposits of the Peruvian coast, depicting a man being bitten in the penis by a snake. This *motif* is known on certain Mochica ceramics[2], but otherwise appears to be absent from Peruvian iconography.

We are engaged in the collection of all available data on the archæology of the now exhausted Peruvian guano deposits. The available information strongly indicates that important chronological and climatological results may be expected from this neglected field. We are therefore anxious to trace any further references to the material known to Forbes, as no published figure of an object from the guano, exemplifying the *motif* in question, is known to us. If the objects could be identified and were accompanied by indications of locality and depth, they would probably provide an important addition to the very restricted series of authenticated finds of early Peruvian cultures in guano. David Forbes is known to have made extensive mineralogical, geological and ethnographic collections; but the fate of these and of his extensive manuscript notes, not mentioned in his will, are unknown to us. We should be most grateful for any information that would lead to the discovery of this or of any other guano finds.

GEORGE A. KUBLER.
G. E. HUTCHINSON.

Yale University,
New Haven, Conn.

[1] *Verhandl. Berliner Ges. f. Anthropol. Ethnol. u. Urgeschichte*, 154 (1873) in *Z. Ethnol.*, **5** (1873).
[2] For example, "Cerámicas del antiguo Perú, coll. Wassermann-San Blas", privately printed (Buenos Aires, 1938), 272–73, Figs. 471, 742.

# MEDICAL STUDIES IN BRITAIN

FROM time to time the *British Medical Bulletin* publishes articles by experts on the development of medical studies in Britain. The first of these, on the development of ophthalmology (*Brit. Med. Bull.*, 1, 100; 1943), was noticed in *Nature* (153, 383, March 25, 1944). The second, third and fourth have now appeared (*Brit. Med. Bull.*, 2, Nos. 5–6; 1944). The second is on the genetic aspect of disease, by Dr. Julia Bell; the third is on obstetrics, by Prof. James Young, of the British Postgraduate Medical School, London; the fourth is on oto-laryngology, by Dr. Douglas Guthrie.

Dr. Bell, beginning with a quotation from Hippocrates (400 B.C.) on the hereditary origin of epilepsy, briefly outlines the subsequent history of ideas on the hereditary nature of some diseases. What she tells us of Karl Pearson is interesting because she was his assistant during 1908–14. Her discussion of modern genetics is a valuable summary in the short space available of a complex subject. Fundamental features of this third period of her survey have been the conception of the gene and its localization in the chromosome, and the study of linkage. Work of this kind has, she says, a limited application to hereditary disease in man, but notable work has been done on colour blindness and hæmophilia. The work on blood groups has been among the most important of the single discoveries made. Dr. G. L. Taylor, Dr. R. R. Race and Dr. W. T. J. Morgan have explained this work in an issue of the journal which is devoted to the blood and some of its disorders (*Brit. Med. Bull.*, 2, Nos. 8–9; 1944). The collection of the pedigrees of disease continues, says Dr. Bell, and there can be few in Great Britain who are better qualified than she is to discuss this method of investigation. She also discusses genetic work on cancer and leukæmia. If it is not possible, she says, to stay the onset or course of disease or of a defect which is genetically determined, preventive measures, such as the discouragement of consanguineous marriages or voluntary sterilization of possible transmitters of such diseases, have been considered. Dr. Bell concludes that little is to be expected from the former method, and that the latter may be very wasteful. There is, she thinks, great promise in the work now being done in experimental genetics and embryology, but the results obtained by the study of relatively primitive organisms should be applied to the human species with caution. The selected bibliography which she gives is valuable.

Prof. James Young traces British midwifery back to the reign of Henry VIII, when, in 1540, the first British text-book on the subject appeared—a translation of Rösslin's book published in Hagenau in 1513. Little progress was made during the sixteenth and seventeenth centuries, when practitioners of midwifery were mostly the ignorant and illiterate midwives who called in the doctor "with his destructive instruments" in emergencies. But Paré, in France in 1550, discovered the value of podalic version, and from this Prof. Young dates the rise of modern obstetrics. Obstetric forceps, "one of the greatest and most beneficent of all obstetric discoveries", were invented about 1630–34, but they remained a close secret of the English Chamberlen family for more than a century. Their use did not become general until Chapman first described them in 1713. It was William Harvey who introduced a new intellectual spirit into the study of obstetrics, but he strangely failed to realize the truth taught by his teacher Fabricius that the child is born by the muscular action of the womb, insisting that it "attacks the portals of the womb" and gets out by its own efforts. Harvey and others, including the Chamberlen family, made improvements in the status and instruction of midwives, and some control of them was instituted.

Harvey and his friends emphasized that labour was a natural physiological process and did not favour interference until it was clear that it was necessary; and this idea dominated the British school of obstetrics throughout the eighteenth century. By the middle of this century the British school had made such progress that it led the world. The genius of William Smellie (1697–1763) earned for him the description as "one of the most important obstetricians of all times and all countries". Prof. Young gives an interesting description of the fight between the men and women midwives. It is only recently that the British midwife has been given by the Midwives Act of 1902 and subsequent legislation "a position of prime importance in the maternity organization of the country". With the nineteenth century came anæsthesia, antiseptic and later aseptic surgery, and the story of the control of puerperal sepsis, the contagious nature of which was suspected by Gordon in Aberdeen in 1795 and independently in 1843 by Oliver Wendell Holmes in America and by Semmelweiss in Vienna. The fact that a streptococcus was the cause was demonstrated by Pasteur in 1867. British bacteriologists have played a notable part in the prevention of obstetric contagion.

The rest of this interesting article deals with the history and present position of preventive aspects of obstetrics and with the recognition of obstetrics as a special branch of medicine. "Gynæcology," says Prof. Young, "is a creation of the nineteenth century." It dates from the work of Virchow and the creation of the microscope. In the same issue of the *British Medical Bulletin*, Dr. W. C. W. Nixon writes on nutrition and pregnancy and lactation, and there are valuable reviews of selected papers on subjects of obstetrical and gynæcological interest.

Dr. Douglas Guthrie's article on oto-laryngology takes us back to Fallopius, whose name is familiar to every first-year student of biology. Fallopius wrote in 1564 what was probably the first complete book on the ear. It was not until 1748 that Duverney, of Paris, demonstrated that the Eustachian tube was not a means of breathing or hearing, but simply a means of renewing the air in the tympanum. Willis, of Oxford, also known to students of biology and medicine as the discoverer of the 'circle of Willis' and other features of the nervous system, published in 1683 his treatise entitled "Two Discourses concerning the Soul of Brutes", in which he gave an account of the phenomenon of hearing better in a noise (paracusis Willisi) and told of a woman who, though she was deaf, could hear every word perfectly so long as a drum was beaten in her room; her husband kept a drummer so that he could talk to her.

During the eighteenth century two of the most important instruments used in oto-laryngology were invented, both by laymen. Guyot, a postmaster of Versailles, produced in 1724 a form of the Eustachian catheter, which he introduced through his own mouth in order to syringe his ear and so relieve his deafness. In 1854 the Parisian singing master and singer, Manuel Garcia, invented the laryngoscope in order to see the action of his own vocal chords. But

in the eighteenth century oto-laryngology was chiefly concerned with diphtheria, which was very prevalent and fatal then. The first hospital in the world to be devoted to diseases of the ear, the Royal Ear Hospital, was founded in 1816 by J. H. Curtis, an unqualified man who had a large practice in London. The subsequent history of oto-laryngology brings us to Joseph Toynbee (1815–60), the father of Arnold Toynbee, James Hinton (1822–75), also remembered as a philosopher, and Sir William Wilde, of Dublin (1815–76), the father of Oscar Wilde. Toynbee's beautiful dissections were preserved in the Museum of the Royal College of Surgeons until they were destroyed by enemy action in 1941.

Laryngology became a special branch of medicine in the middle of the nineteenth century and Sir Morell Mackenzie was the founder of modern laryngology. Another great laryngologist was Sir Felix Semon, a German pupil of Mackenzie's who settled in London. Semon was one of the last to practise laryngology before it became merged with otology. Nowadays developments in bronchoscopy and oesophagoscopy are extending the boundaries of the science of oto-laryngology; and speech and voice disorders offer a further field.

Dr. C. S. Hallpike, in another article in this issue of the *British Medical Bulletin*, discusses research in otology and Dr. E. H. Broome discusses the scope of speech therapy. Dr. Guthrie provides a second article, on "Pioneers in the Teaching of the Deaf". A discussion on the audibility of the radio voice at a meeting of the Royal Society of Medicine will interest lay readers who are habitual radio listeners. It is evident that the radio speaker has to deal with a complex problem. Mr. John Snagge said in this discussion that it is impossible to tell from gramophone records whether a speaker will be a success at the microphone, and also that the construction or lining of the walls of a room in which a broadcaster speaks has little effect on the reception of his voice by the distant listener. The quality of the voice is often more important than the speed of the speech.

Peripheral vascular disorders are the subject of a valuable article by Prof. J. R. Learmonth (*Brit. Med. Bull.*, 2, No. 7; 1944). This issue is devoted to the peripheral blood vessels and deals with arterial spasm, arterial injuries and injuries due to low temperature, such as frostbite. Fifteen photographs illustrate the article on the pathology of immersion foot. The study of these conditions is always an important one, but it is perhaps even more important in these times of war and air-raid casualties.

G. Lapage.

# DECIDUOUS CYPRESS (*Taxodium distichum*)

By ALEXANDER L. HOWARD

This beautiful tree, the only cypress which sheds its leaves in the winter, is far too little known and appreciated by those who possess it. In spring its light-coloured feathery leaves fall gracefully from the pyramidal shape of the tree; in summer the full effect of the foliage is different from anything else in the landscape; in autumn it reaches perfection, when the sprays turn a golden hue, almost reminiscent of a set piece in a firework display; and in winter its curious habit of growth attracts the eye, because of its weird, almost ghostly appearance.

It is known in the United States by the names of bald cypress, swamp cypress and Louisiana cypress, and according to Sargent "rarely 12 feet and generally 4–5 feet in diameter above the abruptly enlarged strongly buttressed usually hollow base", occasionally 150 ft. high, but in Great Britain the maximum height and girth recorded is 110 ft. by more than 12 ft.

It is to be found sparsely distributed over a wide area, generally by the banks of streams, rivers or lakes. While it can be reared apart from such positions, it is essentially a tree dependent upon water-ways. Introduced from other countries, it has both suffered and benefited by the fashion of the day. For the last half-century it has been almost forgotten, while in the beginning of the nineteenth century it was extensively planted, and a number of these trees are still flourishing to-day, but inquiries I have made seem to show that few, or perhaps scarcely any, have been planted during the last half-century. Interesting accounts of many fine examples are catalogued by Elwes. He mentions:

> "The trees at Syon have been frequently described and figured. They are planted in damp soil by the side of a sheet of water, and one of them has produced knees of 1 to 2 feet high. This tree . . . measured in 1903 90 feet by 12, but there is a much taller one on the other side of the water, which when we saw it last, in 1905, was 110 ft. high, and is the tallest we know of in Europe. Another, in the Duke's Walk, is 85 feet by 10 feet 3 inches."

In October 1944 I visited Syon and the trees were in perfect health. I was doubtful which one Elwes found to be 90 ft. by 12 ft., but I measured the largest, which exactly answered his description of site, and found it to be 21 ft. around the base. The knees rising to 2 ft. and a little more range around the tree on three sides—on the south side to 52 ft., on the west side to 46 ft., and on the north side to more than 40 ft. There is also on the other side of the walk a very handsome young tree about 80–90 ft. high and 12 ft. girth at the base.

Elwes also reports:

> "At White Knights, Reading, there are several trees, but none of large size, the biggest measuring, in 1904, 67 feet by 7 ft. 10 inches. They are remarkable, however, for variety of habit. One is a tall narrow tree with upright branches, almost fastigiate. In another tree the stem is twisted, as often occurs in the chestnut, and most of the branches are twisted also in the direction against the sun. Loudon mentions these as young trees of peculiar habits."

Mr. F. G. Franklin, at White Knights, writes to me under date of October 7, 1944, as follows: "the trees you mention are still alive but I could not say they are very much larger than you say."

And further:

> "At Strathfieldsaye there is a tree, mentioned by Loudon as being 46 feet in height by 3 ft. 4 in. in diameter, which I found in 1903 to be 63 ft. high by 9 ft. in girth (I have a letter from the Duke of Wellington in October 1944, in which he informs me this is now 69 ft. and the girth 11 ft. 6 in. at 5 ft.) It is growing in stiff clay soil and has no knees: the stem is deeply furrowed.
>
> "At Coombe Abbey, Warwickshire, Mr. W. Miller reports that a tree, mentioned by Loudon as 47 ft. by 2 ft. 3 in. (diameter e.d.) in 1843, had attained, in 1887, 75 ft. by 11 ft. 6 in. at 3 ft. from the ground. [In answer to an inquiry I am told by Mr. J. G. Gray there has been no such tree there for the past 22 years.]
>
> "At Brockett's Park, near Hatfield, there are many trees planted along a walk on the banks of the Lee, and

forming an irregular line in which the trees vary very much in size. In the sheltered part of the valley, where the soil and situation are very favourable, they average 70–80 ft. high, the best I measured being 80 ft. by 10 ft. and 86 ft. by 9 ft. But lower down the stream, where the valley is more exposed to the wind, they are stunted, and not more than half the height of those above. There are knees on some of the trees overgrown with moss and meadowsweet, but not so large as those at Syon."

I saw these trees in the autumn of 1943 and found them generally in good health, but some damaged by tempest.

In the courtyard of Dartington Hall, near Totnes, a very fine tree flourishes, and this was shown to me by Mr. Elmhurst a few years before the War. When I expressed surprise that this great tree stood alone in good health in an exposed position on the hill, he explained that its roots were in a large disused well. A similar tree is in good health to-day at the Grand Hotel, Lyndhurst, perhaps 70–80 ft. high, where it also is said to have its roots in a disused well. A fine tree about 70–80 ft. high and more than 2 ft. 6 in. in diameter grew by the side of the stream a little north of Hunton Bridge, near Watford, Herts. This may have been the tree which Elwes figures as being, when he measured it, 85 ft. by 14 ft. in 1884. At the request of the owner, about twenty years ago, I had it cut down: reference to the wood will be made later, but I heard a few years after that my brother had known the tree and had landed many good trout under its branches. The two dates of fashionable planting appear to be during 1720–62 and in 1843, and choosing between these without further information, I think this tree must have belonged to the earlier date. Inquiries over twenty years gave disappointing results, as few trees could be found of later planting. Some good specimens can be seen at the Pinetum at Bedgebury. Mr. W. Dallimore writes me under date of October 11, 1944, as follows:

"The Taxodiums at Kew are, I imagine, from 75 to 80 years old, although I cannot be certain on the point. The Taxodiums at Bedgebury are all quite young. Some were planted in 1926, others in 1927, and they were 3 to 4 years old when planted."

The varying habit of growth is characteristic of the tree in the United States, and it is the same in Great Britain. This feature is noticeable when the limbs are bare, and this ghostly appearance, previously referred to, stands out against the winter sky.

The wood is of great value, and so far much too little appreciated in Britain. Quoting from "Timbers of the World":

"It is imported in the form of planks and boards of various qualities, but only of late years in any considerable quantity. It is yellowish-red, often nearly salmon coloured. In the United States it is used so extensively that Gibson writes 'the uses are so nearly universal that a list is impossible'. Another American authority, Hough, says: 'Its great durability, immunity from the attack of parasites, and non-liability to great shrinking or warping makes it one of our most valuable woods for all woodwork exposed to weather, for tank construction, cooperage, etc.'. These qualities combined with a sharp segregation of the hard and soft grain, and with a scantiness of resin, should bring this wood into more general use. It is especially satisfactory for out-houses and green-houses, and where so used will probably outlast any other kind of softwood, even when unpainted. One such unpainted building in this country has survived for six years (1920), and the wood, though subject to continual heat and moisture, is quite sound throughout. [Inquiry to-day (1944) shows that the woodwork in the orchid-houses referred to is in perfect condition, without showing any sign of decay.] The English grown wood appears to possess equally good qualities, and where available should be used for exposed woodwork. It differs from the American grown timber that reaches this country in colour, which is light yellow, and in appearance it recalls Lebanon cedar. . . ."

Gibson has made a statement which suggests that the remarkable durability of this wood is somewhat doubtful, but there is reason to question his opinion. Prof. C. S. Sargent, in a private letter (March 3, 1915) on this subject, says:

"The wood (*Taxodium distichum*) is considered to be exceedingly durable, and I do not know on what authority Gibson has made his statement. It is not impossible, of course, that the wood of a diseased tree, or one that had grown under abnormal conditions, might be of poor quality."

A very large quantity was purchased by the British Government during the War for aeronautical construction, but it was found to be unsuitable, and led to deplorable results.

Its great durability renders it most valuable, but the foregoing is an illustration of the undesirability of accepting a timber based upon mechanical experiments, and lends a strong argument in favour of following the advice of the unprejudiced craftsman.

This tree, not indigenous to Great Britain, should be planted wherever possible, for its great beauty and utility: it must be borne in mind, however, that in its native habitat it grows in close proximity to streams or abundant water supply.

## NORTH AMERICAN ARCHÆOLOGY AND CULTURES

BULLETIN 133 of the Bureau of American Ethnology (Washington, D.C.: Gov. Printing Office. 1 dollar) includes seven Anthropological Papers (Nos. 19–26) of varying importance, dealing with the American Indians and their cultures.

Dr. P. Drucker contributes a useful survey of northern North-West Coast archæology, which, in contrast to the ethnology of the region, has been much neglected. The paper is based on his own field-work on a number of middens in the country occupied by the coast Tsimshian and Kwakiutl in historic times, supplemented by a summary of previous publications and museum collections. No marked difference is apparent between the cultures excavated and those of the recent tribes, but Dr. Drucker believes that some kind of culture sequence will yet be found, on the analogy of neighbouring areas. Finally, it is suggested that both archæological and recent cultures of the northern North-West Coast fall into three main geographical divisions, described as the northern (Tlingit-Haida-Tsimshian), the Milbanke-Queen Charlotte Sound (Kwakiutl), and the Straits of Georgia-Puget Sound aspects.

A large part of the volume is occupied by a study of the Eastern Cherokees of North Carolina by W. H. Gilbert, jun., based on two years of research which included a four-months sojourn among them. A survey of the culture of this remnant is followed by a description of the state of the tribe in former times, culled very largely from MS. data collected by J. H. Payne in the first half of the nineteenth century. Comparison between the two periods shows not only

the inevitable impoverishment of culture caused by contact with the white man, but also certain fundamental changes. The social organization of the older society, with its white and red officials for peace and war, conforms in general with that of other south-eastern tribes. The surviving remnant has lost this dual division, and has developed other features of which the most striking is a system of preferential mating; this has become linked with the matrilineal clans to which most members of the tribe still belong. The essence of this is that a person is expected to marry into one of his grandfathers' clans, but not into those of his parents, a state of affairs which was happily expressed by an Indian informant who said, "The Cherokees marry their grandmothers!" This system is unparalleled anywhere outside Australia, and its appearance is used to point the moral that a study of the historical antecedents of a tribe will not necessarily throw light on its present-day organization. A feature of this paper is a series of elaborate family-tree diagrams.

Another paper on the social and religious life of a dying Indian society deals with the Carrier Indians of the Bulkley River basin in British Columbia. It is contributed by D. Jenness, who spent about four months among them. A good account is given of the political organization, including the part played by clan and personal crests, and there is a brief summary of the life-cycle. The section on religion includes an interesting account of some hybrids formed by the impact of Christianity on the old beliefs, and the importance of dreams in the religious life of the people is stressed. The remarkable lack of historical sense among these people is shown in the impossible stories which they weave around events scarcely a generation old. The paper ends with an account of the medicine men, which includes a remarkable first-hand description of a ceremony for the cure of 'kyan sickness', a kind of hysteria involving cannibalistic cravings, to which these Indians seem particularly susceptible.

A paper by Robert F. Heizer on "Aconite Poison Whaling in Asia and America" gives a survey of whaling along the North Pacific coasts from Japan to Vancouver Island, which shows that three basic methods were practised. Netting is found mainly in Japan, the harpoon-line-float method is practised by the Eskimo and Chukchee in the Far North and is also found in the Vancouver - West Washington area, and spearing with a lance dipped in aconite poison predominates in the intermediate regions of both Asia and America. It is concluded that the poisoning method was used first by the Ainu and by the Kamchadal of Kamchatka, whence it is conjectured that it spread to the Aleutian Islands and the neighbouring part of the mainland of Alaska. It is probable that the movement was in this direction, but a word of caution is necessary since the link between the two areas is weak at its western end, because evidence for the ancient occupation of the Commander Islands is lacking.

In "The Quipu and Peruvian Civilization", John R. Swanton, arguing from quotations from the chroniclers, concludes that the quipu was used as a more extensive method of expression than the mere recording of numbers. From analogy with other high civilizations, he considers that Andean culture must have had such a mode of expression—a singularly unconvincing argument. It is suggested that the most highly developed quipus are likely to have been in public repositories which the Spaniards destroyed.

G. H. S. BUSHNELL.

# FORTHCOMING EVENTS

## Saturday, December 16

PATHOLOGICAL SOCIETY OF GREAT BRITAIN AND IRELAND (joint meeting with the BIOCHEMICAL SOCIETY) (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 11 a.m.—Discussion on "Cancer".

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 2.30 p.m.—Mr. D. MacFarlane: "Mine Ventilation with reference to Fan Types and their Application".

QUEKETT MICROSCOPICAL SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. W. S. Bristowe: "In Quest of Spiders".

## Monday, December 18

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S.W.7), at 8 p.m.—Mr. and Mrs. Harold Ingrams: "Hadhramaut in Time of War".

## Tuesday, December 19

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Dr. O. Samson: "The Place of China in an Ethnographical Museum".

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. I. E. Coop and Mr. A. L. Poole: "Scientific Collaboration between the United Kingdom and New Zealand in War and Peace".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "Aspects of the Housing Problem" (to be opened by Mr. Alexander Block).

ROYAL INSTITUTION (at 21 Albemarle Street, Piccadilly, London, W.1), at 5.15 p.m.—Sir Henry Dale, O.M., G.B.E., Pres.R.S.: "Modern Developments in Chemical Therapeutics", (iii) "Penicillin and Antibiotics".

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Television-Receiver Sound Channel" (to be opened by Mr. D. C. Espley).

## Wednesday, December 20

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1) at 2 p.m.—Discussion on "The Principles and Relationships Involved in Medical and Veterinary Education" (to be opened by Sir Henry Dale, G.B.E., O.M., P.R.S., Prof. J. B. Buxton and Prof. G. W. Pickering); at 4.30 p.m.—Dr. J. D. Rolleston: "The Folk-lore of Toothache" (C. E. Wallis Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (LONDON STUDENTS' SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. J. F. Stirling: "The Condensation of Atmospheric Moisture on Insulation Surfaces".

## Friday, December 22

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6 p.m.—Dr. H. Orenstein: "Methods and Motion Study Applied to the Shipbuilding Industry".

ASSISTANT TO THE ADVISER IN MYCOLOGY for the Western Province under the scheme of the Ministry of Agriculture and Fisheries—The Principal, Department of Agriculture and Horticulture, Long Ashton, Bristol (December 28).

AGRICULTURAL TRAINING OFFICER to organize the training in Agriculture and Horticulture of men and women released from War Service—The Executive Officer, Kent War Agricultural Executive Committee, County Hall, Maidstone (December 30).

DEPUTY CITY ELECTRICAL ENGINEER AND MANAGER—The Electrical Engineer, Electricity Works, Peterborough (endorsed 'Application for Deputy Electrical Engineer') (December 30).

ASSISTANT TO THE ADVISORY CHEMIST, Department of Agriculture—The Secretary, School of Agriculture, Cambridge (December 30).

ORGANIC CHEMIST on the staff of the Council for Scientific and Industrial Research, Division of Industrial Chemistry—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2 (December 31).

LECTURER (full-time) IN ENGINEERING in the Ashington Mining School—The Director of Education, County Hall, Newcastle-upon-Tyne 1 (December 31).

SENIOR LECTURER IN AGRICULTURE, and a BURSAR—The Clerk to the Governors, Royal Agricultural College, 7 Dollar Street, Cirencester (January 1).

TECHNICAL ASSISTANT IN THE HULL ELECTRICITY DEPARTMENT—The General Manager, Electricity Offices, Ferensway, Hull (January 1).

INSPECTOR OF AGRICULTURE, Sudan Government—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3285.A) (January 2).

CHIEF ENGINEER of a large factory in Lancashire which, though not making machinery itself, uses a wide variety of machinery in its own processes—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. C.2384.XA) (January 8).

SENIOR PROFESSIONAL OFFICER (temporary), Industrial Diamond Research, University of the Witwatersrand, Johannesburg—The Secretary, Universities' Bureau of the British Empire, c/o University College, Gower Street, London, W.C.1 (January 15).

ASSISTANT LECTURER (Grade III) IN THE DEPARTMENT OF ZOOLOGY—The Registrar, The University, Liverpool (January 20).

ASSISTANT IN THE DEPARTMENT OF ZOOLOGY—The Registrar, The University, Liverpool (January 20).

CHAIRS OF POLITICAL ECONOMY AND ENGINEERING—The Secretary, The University, Aberdeen (March 31).

LECTURER IN GEOGRAPHY—The Secretary, The University, Aberdeen (March 31).

JUNIOR LECTURESHIP IN CHEMISTRY—The Secretary, Queen's University, Belfast (April 30).

TEACHER (man or woman) qualified to teach SCIENCE and MATHEMATICS in the Junior Technical and Day Continuation School—The Organizer of Further Education in Rugby, College of Technology and Arts, Eastlands, Rugby.

LECTURER (full-time, man or woman, temporary) IN BIOLOGY in the Leeds College of Technology—The Director of Education, Education Offices, Leeds 1.

ASSISTANT MASTER to teach MECHANICAL ENGINEERING Subjects—The Principal, Technical College, Wolverton, Bucks.

GRADUATE TEACHER (full-time) OF ENGINEERING for Day and Evening Classes in the Crewe Technical College—The Director of Education, County Education Offices, City Road, Chester.

ELECTRICAL OR MECHANICAL ENGINEER (Graduate or with equivalent qualifications) to teach ENGINEERING DRAWING, ENGINEERING SCIENCE, or MATHEMATICS, in the Maidstone Technical Institute—The District Secretary, Kent Education Committee, 13 Tonbridge Road, Maidstone.

GRADUATE LECTURER IN MECHANICAL ENGINEERING, mainly for Junior Day Work with some Senior Full-time or Part-time Day and Evening Classes in the Southend Municipal College—The Chief Education Officer, Education Office, Warrior Square, Southend-on-Sea.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

Annotated Equilibrium Diagram Series. No. 2: The Equilibrium Diagram of the System Copper—Tin. By Dr. G. V. Raynor. Pp. 6. 6*d*. No. 3: The Equilibrium Diagram of the System Copper—Zinc. By Dr. G. V. Raynor. Pp. 6. 6*d*. No. 4: The Equilibrium Diagram of the System Copper—Aluminium. By Dr. G. V. Raynor. Pp. 6. 6*d*. (London: Institute of Metals.) [1710

Tory Reform Committee. Bulletin No. 7: The Control of Land Use. Pp. 16. (London: Tory Reform Committee.) [1910

Department of Scientific and Industrial Research: Forest Products Research Laboratory. Leaflet No. 34: The Identification of Timbers. Pp. 10. Leaflet No. 35: The Construction and Operation of Charcoal Kilns. Pp. 12. Leaflet No. 36: Some Observations on Timber-Drying Kilns and their Proper Use. Pp. 6. Leaflet No. 37: Selecting Ash by Inspection. Pp. 6. Leaflet No. 38: Termite-proofing of Timber for Use in the Tropics. Pp. 6. (Princes Risborough: Forest Products Research Laboratory.) [1910

Ministry of Fuel and Power. Twenty-second Annual Report of the Safety in Mines Research Board, 1943. Pp. 30. (London: H.M. Stationery Office.) 1*s*. net. [2310

Ministry of Agriculture and Fisheries. Bulletin No. 128: Wireworms and Food Production; a Wireworm Survey of England and Wales, 1939–1942. (Report from the Advisory Entomologists' Conference.) Pp. 62. (London: H.M. Stationery Office.) 1*s*. net. [2310

Agricultural Research Institute of Northern Ireland. Seventeenth Annual Report, 1943–44. Pp. 36. (Hillsborough: Agricultural Research Institute of Northern Ireland.) [2410

Dust Diseases: their Cause and Care. Pp. 16. Learning to Live: a Word of Encouragement for the Patient. Pp. 24. (London: National Association for the Prevention of Tuberculosis.) Specimen copies, free; 10*s*. per 100. [2510

Proceedings of the Royal Irish Academy. Vol. 50, Section A, No. 1: Remarks on the Self-Energy Problem. By W. Heitler. Pp. 6. n.p. Vol. 50, Section A, No. 2: A Note on the Evaluation of the Schrödinger Hydrogenic Intensity Integral. By T. S. Wheeler. Pp. 7–12. n.p. Vol. 50, Section A, No. 3: A Convenient Method of Measuring the Intensity of Nuclear Scattering of Fast $\beta$-Particles in a Cloud Chamber. By C. O. Ceallaigh and M. D. MacCárthaigh. Pp. 13–27. 1*s*. Vol. 50, Section A, No. 4: On the Connection of Dirac's Quantum-Electro-Dynamics and the Theory of Radiation Damping. By P. G. Gormley and W. Heitler. Pp. 29–49. 1*s*. Vol. 50, Section A, No. 5: The Equilibrium of Small Ions and Nuclei. By P. J. Nolan and R. I. Galt. Pp. 51–68. 1*s*. Vol. 50, Section B, Nos. 1, 2, 3: 1. The Electrical Production of Semen in the Guinea Pig (*Cavia cobaya*) and the Characters of the Ejaculate; 2. Note on the Sudanophile Fat in the Testis of the Dog; 3. Non-Septic Spermiophagia in the Male Guinea Pig (*Cavia cobaya*). By L. Collery. Pp. 38+5 plates. 3*s*. Vol. 50, Section B, No. 4: List of Irish Fresh-Water Mites (Hydracarina). By J. N. Halbert. Pp. 39–104+plates 6–14. 4*s*. 6*d*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [2610

To-morrow's Children. Issued by the Tory Reform Committee. Pp. 32. (London: Europa Publications, Ltd.) 1*s*. [3010

Post-War Development in Radio Engineering. Part 2: Education and Training. Pp. 12. (London: British Institution of Radio Engineers.) [3010

## Other Countries

Transactions of the San Diego Society of Natural History. Vol. 10, No. 8: The Widewinder, *Crotalus cerastes*, with Description of a New Subspecies. By Laurence M. Klauber. Pp. 91–126+plates 6–7. Vol. 10, No. 9: New Occurrences of Fossil Tapir in Southern California. By Chester Stock. Pp. 127–130. (San Diego, Calif.: San Diego Society of Natural History.) [1210

Publications of the South African Institute for Medical Research. No. 46: South African Food Tables; Chemical Composition and Vitamin Content of Common South African Foodstuffs. By Dr. F. W. Fox and Dr. L. Golberg. Pp. 123–162. (Johannesburg: South African Institute for Medical Research.) [1210

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 168: A Survey, Census and Statistical Study of the Horticultural Plantings on the Murrumbidgee Irrigation Areas, New South Wales. By A. Howard and G. A. McIntyre. Pp. 88+7 plates. Bulletin No. 170: Pea Mosaic on *Lupinus varius* L. and other Species in Western Australia. By D. O. Norris. Pp. 27+2 plates. Bulletin No. 175: The Recovery of Inter-Block Information in Quasi-Factorial Designs with Incomplete Data, 2, Lattice Squares. By E. A. Cornish. Pp. 19. Bulletin No. 176: The Analysis of Cubic Lattice Designs in Varietal Trials. By Dr. I. F. Phipps, A. T. Pugsley, S. R. Hockley and E. A. Cornish. Pp. 40. (Melbourne: Government Printer.) [1210

Gold Coast Colony: Department of Agriculture. Report on the Central Cocoa Research Station, Tafo, 1938–1942. Compiled and edited by M. Greenwood. Pp. ii+64. (Accra: Government Printing Department.) 4*s*. [1710

Western Australia. Report of the Geological Survey for the Year 1940. Pp. 20+3 plates. (Perth: Government Printer.) [1710

Western Australia: Geological Survey. Bulletin No. 100: Part 1, The Blue Asbestos bearing Banded Iron Formations of the Hamersley Ranges, Western Australia, by Keith R. Miles; Part 2, The Blue Asbestos Deposits of the Hamersley Range and their Economic Importance, by J. S. Foxall; with two Appendices, i. The Yampire Gorge Crocidolite Deposits (1937), by F. G. Forman; ii. Report on the Hamersley Range Blue Asbestos (1938), by J. S. Foxall. Pp. 62. (Perth: Government Printer.) [1710

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 23, No. 37: Classification of the Ermines of Eastern Siberia. By E. Raymond Hall. Pp. 555–560. Vol. 23, No. 38: Notes on some Unfigured Type-Specimens of Chinese Mollusks from the North Pacific Expedition. By Teng-Chien Yen. Pp. 561–586+plates 50–51. Vol. 23, No. 39: *Rhinobrycon negrensis*, a New Genus and Species of Characid Fishes from the Rio Negro, Brazil. By George Sprague Myers. Pp. 587–590. (San Francisco: California Academy of Sciences.) [2310

Science in Childhood Education. By Prof. Gerald S. Craig. (Practical Suggestions for Teaching, No. 8.) Pp. viii+86. (New York: Teachers College of Columbia University.) [2310

Publications du Centre National de la Recherche scientifique. Monstruosités florales concernant particulièrement les nectaires chez une crucifère de la tribu des hesperideæ. Par Prof. Jean Motte. Pp. 10. Zoologie saharienne. Par Prof. L. G. Seurat. Pp. 58. (Alger: Centre National de la Recherche scientifique.) [2310

Annual Report of the Imperial Council of Agricultural Research for 1942–43. Pp. 36. (Delhi: Manager of Publications.) 2.6 rupees; 4*s*. [2710

Indian Association for the Cultivation of Science. Annual Report for the Year 1943. Pp. 2+32. (Calcutta: Indian Association for the Cultivation of Science.) [2710

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series A, No. 60: Preliminary Observations on the Suitability of Cotton Cloth for covering Bales instead of Hessian. By C. Nanjundayya and Dr. Nazir Ahmad. Pp. ii+10. 12 annas. Technological Bulletin, Series B, No. 32: Variation in Copper Number, Cuprammonium Fluidity and Fibre Strength of Cotton stored under High Humidity. By C. Nanjundayya. Pp. ii+8. 8 annas. (Bombay: Indian Central Cotton Committee.) [2710

## Catalogue

A Catalogue of Books of English Literature and History (including Translations) printed during the Nineteenth and Twentieth Centuries. (No. 625.) Pp. 60. (London: Bernard Quaritch, Ltd.)

# NATURE

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CONTENTS



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## DEMOBILIZATION AND THE ALLOCATION OF MAN-POWER

THE debate in the House of Commons on November 16, although taking place before the appearance of the second White Paper on the Re-allocation of Man-Power—that dealing with civilian employments—made it clear that, subject to one criticism, the scheme outlined in September for the re-allocation of man-power between the Armed Forces and civilian employment during any interim period between the defeat of Germany and the defeat of Japan (Cmd. 6548. London: H.M. Stationery Office) went far to meet the desiderata laid down in the various statements and reports on demobilization that had previously appeared. Mr. Bevin's speech in particular showed that in its proposals for the orderly unwinding of the man-power of the country, the Government has had the closest regard to such suggestions. It was equally clear from speech after speech that the proposed arrangements met the crucial test almost invariably proposed in such reports: they are readily understood and accepted as fair in the Forces. The debate itself should help to carry that understanding and acceptance a stage further; for no one who followed it could have any doubt as to the Government's determination that there should be no evasion of the principles laid down, or of the support from all quarters of the House for the view that only on the clearest grounds of public interest should there be any exception to the order of release laid down.

The one major criticism or reservation was that insufficient consideration was given to the claims of men who had served for a long period overseas without home leave. Those claims were pressed on the Government with great skill, sincerity and force, not merely by several serving members but also by others, sometimes perhaps with a zeal which tended to overlook the fact that what was under debate was not demobilization in the true sense, but as the White Paper emphasizes, the re-allocation of man-power. "General demobilization," it is emphasized, "either of the Armed Forces or of war industry, cannot take place until the end of the war against the Axis Powers and their total defeat throughout the world." The Government's plan is framed on the basis that hostilities will end first in Europe, and it relates solely to the interim period between the defeat of Germany and the defeat of Japan. It is governed by the paramount consideration that there can be no break in the war effort after hostilities cease in Europe, and that in association with the other Allied Powers at war with Japan there must be the maximum deployment of the forces needed to bring complete and final victory at the earliest possible moment.

It is, of course, true that if demobilization plans are to be understood and accepted as fair in advance, above all by those most concerned, namely, members of the Forces, they must be prepared and explained long before hostilities come to an end. Any misunderstanding on this point should be removed by

the Prime Minister's firmness and explicitness ; but his subsequent announcement on November 17 of the new scheme for a system of short home leave for troops serving overseas goes some way to meet the major reservation in the welcome given to the re-allocation scheme. There are, however, other considerations of special interest here, not all of which were noticed in the debate on November 16.

That debate was under some handicap in proceeding before the publication of the second White Paper (Cmd. 6568. H.M. Stationery Office, November 1944, 2*d*. net.), and before discussing these particular points the two schemes must be briefly summarized. As an essential part of the re-allocation of man-power, the first scheme proposes to continue the compulsory recruitment of men for the Forces in order to bring relief to the men who have served for long periods and enable more of them to return to their homes. It will also be necessary to maintain the requisite control over industry and labour during the interim period, in which there will continue to be heavy and over-riding demands for munitions of war and other essential production.

Until the requirements for the continuation of the war against Japan and for the garrisoning of occupied countries are finally known, the level at which the Armed Forces must be maintained cannot be determined precisely. While re-allocation between the Armed Forces as a whole and industry will clearly be possible on a substantial scale, the Government affirms that military requirements must over-ride all other considerations. The arrangements must also not be too complicated for practical application, and the Government takes the view that a fair and reasonable scheme can best be secured on the basis of release according to age and length of service. It will also be necessary to make limited provision for certain urgent work of reconstruction on which a beginning must be made in the interim period.

The plan accordingly provides for two separate methods of selecting men for return from the Forces. Class *A* will be selected according to age and length of service ; Class *B* on account of their qualifications for urgent reconstruction work. No man will be released or transferred from the Forces if his retention is considered necessary on military grounds, though the Services will make every effort to release men in their turn in whatever theatre of war they may be serving. Men due for release or transfer will be given an opportunity to volunteer for a further period of service.

The number of releases in Class *A* will correspond with the reduction in the strength of the Forces and will be increased in consequence of the calling up of further recruits. Except that men of fifty years of age and more will be treated as a priority class to be released first if they so desire, men will be released by a combination of age and length of war service, on the basis that two months of service is equivalent to one additional year of age. Release will commence as soon as practicable after the defeat of Germany.

The men in Class *B*, who will be specially transferred from the Forces, will be those identified as belonging to particular occupational classes specified by the Minister of Labour and National Service as required for certain urgent reconstruction employments. The Class will also include a limited number of individual specialists, for whose transfer application may be made through Government departments in accordance with existing arrangements. The transfers in this Class will be few compared with the releases in Class *A*, and the number will be determined from time to time by the immediate requirements for reconstruction, and the extent to which those requirements will be met by releases in Class *A* and by transfer from munitions and other work at home. The men will be liable to be recalled individually to the Forces if they discontinue their reconstruction employment.

Further principles regarding re-allocation are laid down in the second White Paper, on re-allocation of man-power between civilian employments, which itself refers to some of the points made in that dealing with Employment Policy (Cmd. 6527. London : H.M. Stationery Office). The task will be to ensure that our limited resources are concentrated first upon those munitions required for the Armed Forces, and, secondly, upon those products which are most important to national recovery and to an improvement in the standards, not of those who can pay the highest prices, but of the community as a whole. The existing system of allocating man-power to the Forces and to the various industries, based on the annual man-power budget and carried out under the present system of priorities, will be continued. It is believed that the only way to avoid serious dislocation and dissipation of our resources on objects of secondary importance, and the production, so far as practicable, of necessities rather than luxuries, is to re-allocate man-power during this interim period on such a planned basis with some control over industry and labour, in accordance with certain established broad principles.

In the man-power sphere the aim must be to seek to mitigate the severity of the existing labour controls, to pay all possible regard to the natural desires of workers to seek work where they please, and of employers to engage labour freely, and to ensure that the workers which are available are employed in the places where, and on the tasks which, they are most needed in the national interest. Accordingly, the Government's policy endeavours to meet such wishes, especially that to return home, so far as is consistent with due regard for the general well being of the country. Subject to the same over-ruling consideration, it will also be the aim to transfer experienced workers back to their former industries. Release of persons in civilian employment cannot be determined purely by redundancy ; over-riding priority will be given to certain classes who, on personal grounds, have a claim for specially sympathetic treatment in the matter of release for retiring from industry or to work nearer their homes.

When these priority classes have been released some establishments, mainly in the munitions industries, will still have redundant labour, while other

establishments will be requiring labour. The problem therefore becomes one of transfer of labour, with some of the vacancies of greater importance than others; and in this redistribution of labour it is proposed that, apart from the call-up for the Forces, the two main classes to be released first should be those needed for priority vacancies and those who have worked away from home for more than one year and want to return.

As regards men for the Forces, all men in the age groups 18–27 will be liable for calling up; but those in the range 25–27 will only be called up if there are insufficient men in the lower age-ranges to meet requirements. Deferments will continue to be granted for men with special skill. In the selection of workers for transfer to priority vacancies under redundancy, existing selection procedure, which includes consultation with representatives of employers and workers, will be followed, and a major objective will be to transfer as many persons as possible back to their homes. The priority orders will also be applied where necessary to the transfer of workers to industries which need to maintain or increase their labour force. Registration of young men and women for employment or national service will be continued.

While the Government's proposals aim at effecting the necessary redistribution of man-power on a voluntary basis as far as possible and at narrowing the field of compulsion to the strictest limits, a substantial measure of control over the movement of labour must be retained. The Government desires both to give employers as much freedom as it can in the engagement of workers, and to ease the position of as many classes of workers as possible, especially in the older age groups. Controls over juveniles are to be considered in relation to the whole question of juvenile employment and a separate scheme is being worked out in consultation with the interests concerned, the paramount object of which will be to assist juveniles to the maximum extent possible in the choice of employment with the view of giving them the best opportunities for a permanent and progressive career in life with due regard to individual aptitudes.

It is on this question of education and training that criticism of the two schemes as a whole may well centre. The Government recognizes explicitly that the position of those young people returning from the Forces, who have the first claim to resume their education, must be safeguarded, but neither in the debate nor in the White Papers are the full implications of this policy indicated. The significant omissions are references to the release of teachers, and particularly university teachers, and of students to resume their studies.

That the Government has made no pronouncement on this point is the more important because the case for concessions rests entirely on national grounds. It is supremely important that there should be full and widespread public appreciation of the necessity for Government action, and no room for misrepresentation as favoured treatment for a particular class. Moreover, the demobilization of students of itself will be wasteful unless their release is timed with a view to resumption of their studies at the beginning of a course. Such demobilization, from the national point of view, calls for consideration as part of a national policy for youth, in which registration for national service and liability for enlistment in the Armed Forces must be placed in the long-term perspective in relation to educational policy. A decision on the question of a year or other period of national service as part of our national system must be taken at an early date. The Civil Service National Whitley Council has done well to direct attention to this point in its recent report on the staffing of the Civil Service during the reconstruction period.

The importance of higher education may well need some careful and painstaking explanation to the general public before its bearing on the national welfare is understood. Men released from the Forces cannot be accepted for re-training or for university study unless those required to instruct them are previously released from Government service; further, our whole expansion of scientific and industrial research depends on the orderly demobilization and re-allocation of scientific man-power, in which the release of teachers must have a high priority if the recruits required for industry itself are to be available in three or more years time. It must be remembered that for five years practically no male students have taken a university degree except in medicine and certain scientific subjects. Before the War, Sir Richard Livingstone has pointed out, British universities were training barely enough men for the national needs. In these last five years, except for the small fraction exempted from national service for reasons of health, they have been producing no graduates in subjects of such obvious immediate practical necessity to national life as economics, modern languages and the social sciences, in mathematics, history, law, literature, philosophy; and very few in scientific subjects such as botany, geology, and zoology.

While this gap remains, there will of necessity be grave weaknesses in the Civil Service, the professions, the executive ranks of industry and commerce, and the cultural life of the nation as a whole. The closing of this gap is one of the most important reasons for university expansion, and however swiftly the problems there may be solved and however generous the Government's contribution on the financial side, it will take time to close the gap. The men and women of trained capacity so urgently needed in every branch of the national life cannot be produced to order: three years are required for graduation, and several years more for competence in handling public affairs.

Release for this purpose is clearly a complicated question; only those with very special qualifications as students, such as holders of open scholarships, and men and women who have proved themselves first-class teachers, could be considered for priority release. It is all the more important, therefore, that from the national point of view there should be the minimum interruption of studies consistent with the demands

for the prosecution of the War itself. The longer those students who have been called up before completing their courses remain with the Forces, the more wasteful the interruption is likely to be from an educational point of view. Equally, it is important that there should be no further interruptions unless absolutely essential.

It is at this point that, as indicated in three of the articles contributed to the special number of *The Political Quarterly* dealing with the future of the universities, the report of Lord Hankey's Committee is so important. Any preferential demobilization of teachers or university students in Class *B* must clearly be based on the quantitative findings of that Committee as to the probable demand for graduates, and must be related also in some measure to the short-term and long-term development of the universities. Moreover, whether or not the pre-war student population represented, as Dr. Cyril Burt's article suggests, the right proportion of our population qualified to profit by a university education, it is certain, as Sir Lawrence Bragg's article indicates, that not all those best qualified have in fact been included. Apart altogether from Sir Ernest Simon's contention that we have as yet no real evidence as to the proper proportion of the population which is worthy of a university education, the demobilization scheme offers an undoubted opportunity, not only of removing an important bottleneck in reconstruction plans, but also of returning to the university, to the national advantage, some of those promising youngsters of outstanding judgment and intelligence as shown in their record of war service, who through economic or similar reasons have fallen off the educational ladder before reaching the university.

Clearly it might be inequitable to exempt all university students as a class, but the liability to military or other form of national service might well be enforced before or on completion of their university training in accordance with a deliberate national policy on the lines suggested in the Norwood Report and the reports of the British Association Committee on University Education and other bodies. This consideration was not very evident in the debate in the House of Commons on November 16, although Mr. Bevin indicated the Government's acceptance of the view that we must get our educational system going again as soon as possible. Nor was there any reference in the debate to the fact that demobilization of teachers must clearly proceed in stages rather than as one group, in order that the schemes for educational training in preparation for demobilization already announced by the Army and the Royal Air Force (see *Nature*, **154**, 525; 1944) may not be deprived of the instructors and potential instructors necessary for them to function.

Apart from this, the problem of education and teachers in relation to demobilization was fairly raised in the debate by Prof. Gruffydd, who not only made the point of priority in regard to the national needs—though that might have been more forcibly put—but also rightly directed attention to the age factor: the age-level is rising because we cannot get new lecturers, and if anything is important for reconstruction and for new ideas in the country, it is that the university teachers should be young men with young ideas. Mr. Bevin's reply was satisfactory so far as it indicated the Government's appreciation of the seriousness of the position. It may be doubted whether as large a number will be due for release for the universities in Class *A* as he suggested, and few of those thus scheduled will meet Prof. Gruffydd's criterion on the ground of age. Mr. Bevin stated, however, that the Minister of Education and the Secretary of State for Scotland are ascertaining from the local authorities how many teachers they would get back under Class *A*, and that the Government would then see what number is necessary for the schools and also for the universities.

This is undoubtedly the soundest line on which to proceed to establish the case for release on national grounds; but while that quantitative inquiry is proceeding, every effort should be made, both by the Government and by other authorities, to make sure that public opinion fully understands what is involved and the national reasons for priority. There must be no room for misunderstandings on this matter such as those which led to the breakdown of demobilization in 1918, and the same care must be taken in connexion with any and every class of specialist due for release in Class *B*. The efforts in regard to training for industry, whether for research or supervision and administration, and the work of Lord Hankey's Committee to which Mr. Bevin paid tribute, may all be frustrated unless this point is amply safeguarded. Every effort must be made to eliminate any suggestion of special pleading and to ensure that the release of teachers and students is in accord with the wise aims of the demobilization scheme and adequate to serve the country's needs, while avoiding any suggestion that professional interests are favoured other than as they first contribute to the national purpose.

## STATISTICAL THERMODYNAMICS

**Statistical Thermodynamics**

Course of Seminar Lectures delivered in January–March 1944 at the School of Theoretical Physics. By Erwin Schrödinger. (Hectographed.) Pp. ii+135. (Dublin: Dublin Institute for Advanced Studies, 1944.) 5*s*. net.

THIS little volume is not an ordinary text-book, dignified, dull and well printed (hence expensive), but an informal communication of ideas, fascinating, amusing and only hectographed (hence cheap). Its origin and background depend on the peculiar character of the Institute where these lectures were given.

The Dublin Institute for Advanced Studies, housed in one of the pleasant Georgian buildings forming Merrion Square, has at present only two departments, the School of Gaelic Language and the School of Theoretical Physics. The staff of the latter consists of the director, Erwin Schrödinger, and one professor, Walter Heitler, both known well enough in the world of mathematics and physics to need no introduction. The building contains a small but well-selected library, a lecture room and very com-

fortable rooms for the professors, students and guests. Lectures and seminars are given, not according to a fixed time-table and syllabus, but in response to the inclinations of the teachers and the demands of the students. All these attractions are crowned by the non-existence of examinations and degrees—an ideal place for scientific work.

My knowledge of these circumstances is due to the fact that I had the honour of taking part in one of the summer schools at the Institute (July 1943), together with Mrs. K. Lonsdale (Royal Institution, London) and P. P. Ewald (Belfast). These well-attended lectures and discussions on recent research on X-rays were conducted in the typical manner of the Institute—informal, but extremely informative for the students and the lecturers as well. No account of these courses has been published; but those of the previous year, given by Eddington and Dirac, have appeared in print.

The volume at present under review conveys an idea of the *ordinary* courses given at the Institute by its own staff. The programme is best explained in the words of the author himself: "Not a first introduction for newcomers to the subject is intended, rather a 'repetitorium'. The wording is extremely shortened about well known stories to be found in every one of a hundred textbooks, but more extended on some vital points, usually passed over in silence in all but large monographs (as Fowler's, Tolman's)".

The main feature is the systematic use of Gibbs' virtual assembly and the justification given for it. To quote again: "Here the $N$ identical systems are mental copies of the one system under consideration —of the one macroscopic device that is actually erected on our laboratory table. What on earth shall it mean physically to distribute a given amount of energy $E$ over these $N$ mental copies?". This question (given here verbatim to illustrate the style of the book) is answered thus: The $N$ identical systems loosely coupled are considered as a heat-bath of constant temperature and any one of them as the one actually existing. As experience shows that the nature of the heat-bath has no influence on the behaviour of a system in contact with it, this assumption is permissible, and it has great advantages with respect to simplicity and clarity of the argument: the number $N$ can be made arbitrarily large; in fact, one can always use the limit $N \rightarrow \infty$, so that there is no question about the applicability of Stirling's formula for the factorials of occupation numbers; and as each single system is macroscopic, no question about the individuality or indistinguishability of the members of the assembly can ever arise —as it does according to the 'new statistics' if single particles are considered as elements.

In this way the statistical considerations become very simple indeed; one has in all circumstances a Boltzmann distribution of macroscopic elements, but each of these elements is a system described by quantum laws, with a set of (discontinuous) energy states. Schrödinger gives a careful account of the two well-known ways of treating such an assembly, the method of the most probable distribution and the method of mean values due to Darwin and Fowler. The exact relation of these two methods is one of the weak points in most of the ordinary text-books, and a careful study of Section VI, p. 41, of Schrödinger's lectures is recommended to all who aim at a real understanding of physical statistics.

The first method is by far the simplest one, but can scarcely be considered as satisfactory in itself; Schrödinger proves it by demonstrating the identity of its result with that of the second method, which can be rigorously established. This result consists in the definition of the 'sum-over-states' or 'partition function' from which all thermodynamical properties can be derived by simple mathematical processes. The method of Darwin and Fowler for evaluating this sum as a residue (Cauchy's theorem) of a properly constructed generating function is called by Schrödinger a "sublimely excellent device"; and he adds: "But I beg you to keep those two things apart in your mind: *the general proof is done with.* When we use complex integration in what follows, it is *not* in the way of giving an example of the general method, only in the way of using a similar mathematical device or tool for evaluating certain sums-over-states. It is truly necessary to emphasize this point. For when a man has first explained a general method, then deals with particular examples and, in doing so, uses well-nigh the same mathematical device, you are almost bound to think that he does that, quâ applying the general method to the special example." I have quoted this sentence because it sets out a general rule for the teaching of science, which is violated in innumerable lectures and text-books.

The second half of the book contains applications to the $n$-particle system, mainly to the ideal gas. The 'new' statistics of Bose-Einstein and Fermi-Dirac appear as an immediate consequence of the way the total energy of a system of $n$ particles is assumed to depend on the energy levels of the single particles. Great stress is laid on "the failure of the classical theory" (p. 90) as expressed in Gibbs' paradox.

In the last section the theory of radiation is treated, first in the ordinary way leading to Planck's formula. The appearance of the infinite zero point energy then gives the cue for the introduction of a modification of this theory suggested recently by Peng and me. (It was in fact the first published account of it, based on letters, as our paper appeared some months later.) Whether these ideas have any future remains to be seen; I am rather sceptical, since Peng has meanwhile discovered that the difficulties of the ordinary field theories which were to be remedied by the new assumption (divergent integrals in the expressions for the interaction of different particles) are only due to bad mathematics and can be avoided without a new physical hypothesis.

Can scientific writing ever be called a work of art? There are doubtless many people who would claim this title for their own writing, as is illustrated by the true story of the young mathematician, let us call him Paul Lucky, who once went to Rome to attend an international mathematical congress. Not being interested in relics of the ancient world and the Renaissance, he spent all his time in lecture rooms, until his friends insisted that he ought to visit the Sixtine. There he stared awhile at the famous ceiling and said: "Not so bad. But if this chapel and all its paintings crumbled to dust, Paul Lucky's uniformization theorems will still stand."

Well, if there are other passports into the artists' elysium than durability, such as greatness of conception, harmony of structure, charm of expression, I do not know whether Paul has a chance of admission. But I think Schrödinger has; for he writes not only to instruct but also to please. I hope that many readers will enjoy this little work as much as I did. MAX BORN.

# THE CHEMICAL BOND, IN THEORY AND EXPERIMENT

## Valency: Classical and Modern

By Dr. W. G. Palmer. Pp. x+242. (Cambridge: At the University Press, 1944.) 10*s*. 6*d*. net.

THERE is no branch of chemistry in which greater progress has been made in the last twenty years than the study of valency. A full understanding of the principles of chemical combination demands a versatile mind: for it needs to be familiar with what we may call pure chemical reasoning and experiment; it must be on friendly terms with most, if not all, of the tools of modern physics (X-rays, electron scattering, vibration and rotation spectra, electric oscillations, and so on): and lastly, it must not despise mathematics (did not Dirac say, in effect, that all chemistry is a branch of mathematics ?). He who writes a book about valency must decide from the start what kind of approach he will make. To be all-inclusive would require more space than the bare 250 pages which Dr. Palmer has allowed himself; some selection has to be made.

"Valency: Classical and Modern" is a book about chemistry: it is written by a chemist for chemists. But it has this advantage over the old type of chemical treatise, that all other aids to understanding are welcome. So there are paragraphs about the measurement of dipole moments and the interpretation of spin and term diagrams, not usually found in such books. It is hard work fitting everything in, especially when the general approach is historical, so that space is also granted to Dalton and Berzelius. Indeed it is quite remarkable how much information is to be found in this little book. Thus we begin with a historical account of the ideas that led chemists to associate a definite valency (or several possible valencies) with a particular atom. This leads to the periodic system, though it is still unnecessary to introduce specifically electronic theories. The next chapter is devoted to various methods of determining structure and valency; these include stereochemistry studied optically, electric moments, electron diffraction and infra-red spectra. Having established our tools, we are prepared to accept the results that they give, group by group of the periodic table, in the following pages.

So far there is scarcely a mention of electrons; for example, bonds are polar because some unspecified charge is unsymmetrically distributed. But this is not sufficient; a theory of valency is needed, and in the next forty pages the electron spin theory is expounded. This involves us in descriptions of atomic *s* and *p* states and *s-p* hybridization. It is all rather condensed; but everything of importance at this level is included. No wonder that Dr. Palmer claims for these first chapters that "they present a compact but elementary account of classical and modern conceptions of valency . . . not overstraining the capacity of candidates for University examinations of the standard of Part 1 Natural Sciences Tripos at Cambridge". The claim is fair, though he would need to be a good candidate who really understood some of the quantum theory explanations.

There remain about a hundred pages. These are devoted to a series of special problems, with a distinctly more advanced flavour. It is good to see explained the failure of the octet rule for heavier elements: and even better to see so much space devoted to the method of molecular orbitals. Indeed, this is one of the very few chemistry text-books where the advantages of the molecular orbital theory are recognized. There is a lot to be said in favour of the theory if we want a simple visual clear-cut explanation of the multiple links of carbon, revealed, for example, in benzene and other aromatic substitutions. There is a final section on hydrogen bonds.

This latter part of the book is obviously more advanced than the first. It is a pity that it is marred be several mistakes. In one or two places the author appears confused in his description of allowed molecular orbitals. All this is probably explained by the present national circumstances, which make the very appearance of the book a matter for congratulation, but the mistakes (the reviewer has found more than half a dozen significant ones) ought to be corrected as soon as possible.

In conclusion, one cannot help comparing this book with Pauling's classical "Nature of the Chemical Bond". Dr. Palmer's historical approach first introduces the electron-pair bond on p. 112: Pauling introduces it in his first paragraph. The first method is valuable in showing how chemists have thought through their problems to their present knowledge, the second shows how they do think. Pauling has an axe to grind ('resonance, more resonance' is his meat and drink, as they will probably be his last words). But there will be many who will appreciate Palmer's book just because, having no such single idea, he can be fairer to all points of view. Yet this new book lacks the grand scale and manner which have rightly made Pauling's book so famous: "Valency: Classical and Modern" is a sound workmanlike book, but it is not a classic.

C. A. COULSON.

# ELECTRICITY IN PEACE AND WAR

## Electricity and its Application to Civilian and Military Life

By Charles A. Rinde. Pp. xii+467. (London: George Allen and Unwin, Ltd., 1944.) 25*s*. net.

THIS book is written round the United States War Department's outline, "Fundamentals of Electricity", and provides a broad foundation for the fields of specialization suggested by the various technical and field manuals. But its use is not confined to war-time applications of electricity. It is recognized that the same basic principles underlie civilian uses of electricity, and both civilian and military applications are stressed throughout.

The central theme unifying the book is the electron and the control of electrons, and quite rationally the electron is first introduced in the chapter on electrostatics, which comes quite early. It is excellent to find more than customary prominence given to the subject of X-rays, for, as the author very rightly says, "the X-ray is no longer merely a means of examining broken bones".

The text is simply written and easy to follow; it is thus very helpful to those students without previous knowledge of the subject. Many experiments are suggested for the student to carry out, and at the end of each chapter a useful set of questions and problems is provided. There is an abundance of illustrations, and the well-drawn and simple diagrams are a valuable asset to the book which, in spite of war-time conditions, is beautifully produced; a disadvantage is its rather high price.

# SCIENCE AND INDUSTRY IN NATIONAL SECURITY*

By THE HON. ROBERT P. PATTERSON
U.S. Under Secretary for War

THERE is a great voice in the world to-day, the voice of science and technology. It is a voice heard since ancient times but never until to-day has it spoken with such authority, have its words been so filled with promise, has it been listened to with such hope; and in no country in the world does the voice speak so eloquently as in the United States.

Science and technology have changed and are changing the lives of all men. Not a single aspect of our society but feels their advance. The things we make and use, the food we eat, the clothes we wear, the way we travel and communicate, the houses we build, the way we cure and prevent disease, the way we fight—and the way we shall win—have all been fashioned by science. Both war and peace move under the sign of research, discovery and invention.

While our thoughts and energies must still be devoted without stint or limit to the task of defeating Germany and Japan, second place in our thought and planning should be directed to the problems of the future. How shall we repair the ravages of war? How shall we create a society in which full production and full employment can be maintained? How shall we promote and maintain the security of the United States—and thereby contribute to the peace of the world—so that no aggressor will dare again to jeopardize our status as a free people. It is on the last question, on the part which science in industry can play by developing our resources, and advancing our technology in the interest of national security that I would speak.

I conceive the term national security to embrace a wider field than the maintenance of an adequate army, along with the development of powerful and effective weapons; because, in working on the normal products of peace, we at the same time make an essential contribution to our military strength. First, then let me briefly consider national security in its wider sense.

It is to the interest of all that America's scientific men engaged upon both pure and applied research should turn our swords into ploughshares as successfully as they have turned our ploughshares into swords. We shall need the development of new aeroplanes and helicopters, light metals and plastics, television and radio, new foods and medicines as much as we have needed and still need combat aircraft and jet propulsion, heavy armour and new explosives, radar and 'walkie-talkies', high-calorie rations, penicillin and blood plasma. I do not doubt that after victory we shall need the products of peace even more, for ours is not an aggressor country with imperialistic aims; the ideals of our nationalism are the ideals of peace and security.

To get the most out of all science, whether devoted to peace or war, there are certain things to be kept in mind. For one thing, research and development in industry, as in the university, flourish best in an atmosphere of complete freedom; control will wither science by destroying its precious essence of originality and spontaneity. If I were to add to the four freedoms of the Atlantic Charter, I might suggest a fifth—freedom of inquiry, experiment and research.

With that principle in the forefront of our thought, I think we must concede that in view of its position in the modern industrial State, in view of the way science is woven into the cloth of our society, it cannot be left unorganized and unsupported save by sporadic benefactions. A few of the great industries of the United States have been able to establish magnificent laboratories, and the discoveries and inventions flowing from them in a ceaseless stream have enriched our lives in peace and contributed heavily to our ultimate victory in this War. The laboratories of the universities of the United States, especially in the field of pure science, have steadily broadened and deepened the foundations on which all applied science must rest. The laboratories of the Federal Government, in the fields of agriculture, public health, medicine, meteorology and the development of the tools of war have also made an enviable record.

Essential as these contributions have been, we cannot afford to look exclusively to the laboratories and workshops of our major industries, universities and the Federal Government. While important scientific advances are not often made in attic, cellar or barn, as was the case not so long ago, we must not permit the precious stream of discovery flowing from smaller industry and smaller educational institutions to be dammed up by neglect. Small business needs technical information; universities not possessed of vast endowments need help; scientific research and development are of national interest, and whether they be devoted to national defence, public health, public housing or to normal scientific activity for commercial purposes, they must be encouraged, and if they need help they must have it.

Dr. J. B. Conant in a recent address said that the future of the physical sciences depends on the "number of really first class men" that can be turned out by our educational institutions. He urged that talented young men and women be afforded unhampered opportunity for research in both industrial and university laboratories; he advocated Federal scholarships for high-school graduates of technological promise, thus creating what he called "a scientific reserve" for national security. Without considering the exact means required to assure educational opportunities for young men and women of scientific promise, I am in full agreement with Dr. Conant's view as to the need and urgency.

Certain aspects of research, apart from the development of weapons, must, it seems to me, continue to receive Federal support or be carried on by the Federal Government. Agriculture, public health and housing fall in those categories. Certain economic problems also are in need of the clear light of science. The Federal Government, with unique access to full statistical data on population, manufacturing, crops, markets, methods of distribution, is in a position to help shed that light.

Nothing I have said should be construed to mean that in any of these fields the activities of the Federal Government should preclude or foreclose the research and development of private industry or the universities. In normal research and development during peace, the larger share must be contributed by the citizens and not by their Government. That is compatible with the view that in certain types of research the Federal Government must serve the needs of

* Address at the Silver Anniversary Forum on "The Future of Industrial Research", arranged by the Standard Oil Development Company, on October 5.

science. It must act as a stimulating force, it must furnish scientific information, it must lend financial support if it be needed.

In many scientific inquiries there is room for a co-ordination of effort. If it be deemed wise, the Federal Government might be called upon to participate in that function. There is urgent need for the fullest possible exchange of information between scientific workers in industry, academic centres and the Federal Government. How to achieve that co-ordination and a free exchange of data is a basic problem which has not been thought out to a satisfactory conclusion, although much work has been done upon it.

If I may sum up, the job of normal peace-time research is a private job, not a government job. Those branches in which the Government will continue in the principal role are well known; in no way do they conflict with the scientific functions of industry or university. What the Government may do, if it is called upon, is to furnish information and financial support. It may offer counsel, even leadership. It must not, in the normal researches of peace, assume control.

Up to this point I have been talking largely of scientific and technological research which, though of major importance in the national interest, will go on with or without any further plans we may make. But their advance will be facilitated if the factors to which I have briefly alluded are recognized and met.

Research and development devoted to the weapons, tools and techniques of war present us with a tougher problem. Such research will not go on to the extent required for our national security unless support, guidance, even control emanate from central mechanisms.

In time of war, when the nation's existence is in danger, no body of men responds more generously, with greater energy and zeal to the needs of their country than scientific men and technicians. That was our experience in the War of 1914–18; it is also our experience to-day. Industries and universities have turned their laboratories inside out to give their country what it needed, whether they were summoned or not. Men and women who people those laboratories have given us more than we dared hope for. Thousands of lives of our fighting men have been spared, most of the wounded restored to health. Our troops have been equipped with weapons equalling or surpassing those of the enemy; final victory has been brought immeasurably closer, as a result of the efforts of scientific men and technicians.

With all our grumbling, good-natured or otherwise, the fact is that on the home front in the United States we have scarcely felt the War, and that too is in large part to be ascribed to the efforts of our scientific workers.

But when peace comes, ours being a peace-minded nation, we shall have the greatest difficulty in keeping even a small portion of our best scientific brains on the job of maintaining the weapons of our Armed Forces at the high peak of effectiveness they now occupy; unless a suitable programme is evolved to draw and hold scientific men of the highest level, they will not be available for Government service in peace-time to supply the Armed Forces with the best science has to offer. They will return, as is only natural, to the industrial laboratories and the universities they came from. Nor will it be possible in the Government laboratories that will be continued in peace to carry through all the research in ordnance, aviation, radar, rockets and new weapons, in the many specialized nutritional, physiological and other fields which underlie the waging of modern total war. The research facilities and the scientific man-power prerequisite to these activities will simply not be available to the Government in sufficient degree. No acts of Congress or of the executive branch of our Federal Government can alone meet this deficiency. At almost every point of maintaining the technological strength of our Armed Services—whatever mechanism we devise to achieve this end—we shall have to turn to the research laboratories and the research workers of industry and the universities to fulfil our needs.

To some extent, as I mentioned at the outset, our task is made easier—paradoxically, I may say—because modern war is total war. In other words, much of the research carried on by industry and universities to meet the needs of peace will meet the needs of war if this tragedy should be thrust upon us again. In the field of chemicals, rubber, synthetic oil fuel, electrical instruments, engineering products, medicines, light and heavy metals, and food products, research for peace is research for national security. Also in the case of certain end products of purely military use, the intermediary products may be suitable for civilian consumption.

Research and development in connexion with most weapons are in a unique category. A host of factors stand as obstacles where the help of industry and the universities is concerned. Among these are the specialized tools and machinery required, the extensive proving grounds and test plants, the heavy expense, considerations of secrecy, the tenuous and inadequate liaison, during peace, between private industry and the Armed Services, the indifference or hostility of public opinion towards the development of war weapons in times of peace, the competing demands for commercial products.

Aware of the gravity of this problem and anxious to find at least a partial solution, some of the leading men of the National Academy of Sciences, the National Research Council, the Office of Scientific Research and Development and members of the Armed Services engaged upon research and development, have for some time past been weighing the merits of alternative plans for an organization which in the post-war world will deal with military scientific research and attempt to assure to the Armed Services the scientific help and interest required of industry and the universities. I would like to mention briefly some of the questions which this group has had before it, because I believe that these questions are in almost all respects similar to those which industry must answer in developing its policies for research and development pointed towards national security.

The first question is how shall we obtain for the Federal Government the full-time or consulting services of scientific men on the highest level.

It has been suggested that we need an agency, with distinguished leadership, such as we now have in the Office of Scientific Research and Development, and with ample funds, to promote precisely those branches of research and development which will effectively contribute to our military strength. For this is the type of research which if left unattended and unsupported cannot flourish. Between the War of 1914–18 and this War the funds made available for research and development in the military sphere were wholly inadequate. They are adequate now, but they must be kept so. The adequacy of Federal

appropriations to promote military research will determine, in large measure, the contribution that can be asked of private enterprise in terms of personnel and laboratory facilities. While the arguments for the creation of the new agency are impressive, I do not believe that such an agency would fully solve our problem. For the problem is essentially one of men and women, not of organizations. We must have sincere and spontaneous interest in research aiming at national security, and this does not grow out of organizations and subsidies alone, however important these may be.

An important obstacle in enlisting the aid of industry is the difficulty of liaison and interchange between the military services and industry. How can we best meet that problem, recognizing that there is one sphere fully and properly under military control, another fully and properly under private control, but there is a large area of both spheres common to both ? It is manifest that if industry's help in weapon development is needed, so far as the work requires, the military must take industry into their confidence, and vice versa. There must be an avenue between industry, university laboratories, government laboratories, and the Armed Services, and there must be no one-way signs upon it. How can we best achieve this end, not theoretically, but in day-to-day work ?

How shall extensive work in weapon development be financed ? To this there is no simple answer. No industry, however large, can be expected without government subsidy to undertake elaborate research for the weapons of war, especially the accelerated and ceaseless research peculiarly required in this field. How shall this subsidy be administered ? What is its probable magnitude over the next ten or twenty years ?

Financing by way of subsidy or contract payments will, I recognize, often not be enough. We shall need other forms of incentive, financial in character or otherwise. Over and above that, we shall need the approval, the sympathy, the leadership from civilian as well as military circles to enlist public opinion in support of a sound programme.

I know that the exchange of patents and licences in connexion with research on military products is many-sided and troublesome. I mention it also because of its particular concern to industry. I believe, however, that a solution for that question will not be difficult to find, once a basic framework for the entire research and development programme in the post-war world is erected.

What research facilities can and should the Government provide for industry and universities in the United States ? We cannot expect that the research facilities of the Federal Government will be increased after the War ends. We cannot expect, on the other hand, that even the largest industries will be able to provide the proving grounds and more especially the test plants, so that we can convert the successful solution of laboratory problems to successful solutions in production. Proving grounds will doubtless be made available to industry. What of pilot plants ? These questions are, of course, intimately related with the problem as to what research functions in the development of weapons the Federal Government itself ought to continue to perform.

Planning for the results of science is unwise, for results cannot be anticipated. But we must not forgo plans for research, suggestions in definite fields in which valuable results may reasonably be anticipated.

My friends who are scientific workers tell me that so rich and limitless, so untapped are the possibilities of science that the discipline of planning consists as much in saying what roads ought *not* to be followed as what roads ought to be. At every stage of developing our research on weapons we must have a standard of values, so that although research would not be confined, lesser problems would be subordinated to questions of vital national need. That standard of values must be keyed to the current strategic thoughts of our military leaders and must be accessible to the leaders of research. If the link fails in either respect, we cannot expect to gain the full benefit of our vast research machinery. Repeatedly this War has shown that science leads tactics ; this will be fully as true in wars of the future. We will make our plans to suit our weapons, rather than our weapons to suit our plans.

The U.S. War Department has grown increasingly aware of the need for research and development in connexion with new weapons. In partial response to that need there was created within the War Department, more than a year ago, the New Developments Division. This Division is charged with functions relating to the initiation and co-ordination of research and development and the expeditious application of new weapons, devices and techniques. It has proved its usefulness, and will, I hope, continue to do so in increasing measure. Its working relationship with the two scientific agencies to which we all owe so much, the National Research Council and the Office of Scientific Research and Development, has at all times been close and effective. I realize that this Division marks only the beginning of the road to our goal. For in every one of its activities, after the War as now, the War Department must train its men, shape its plans and its actions so as to reflect the most recent advances of science. It must not lose sight of the fact that significant discoveries and inventions are usually the matured products of years of thought and experiment, with innumerable disappointments and failures along the way.

In my judgment a single unified defence agency combining the Army and Navy would go far towards solving many of the problems to which I have referred. The establishment of a corps of scientifically trained officers, for which persuasive arguments have been offered, is only one step of many which the creation of a unified defence agency would facilitate. It is a step which merits serious attention, whether or not a peace-time scientific agency, of the kind I mentioned before, is created. It envisages the training of a group of talented young scientific men, and others with professional skills, within the existing framework of the Armed Services, as an integral part of the U.S. Army and Navy. Members of this group would have their regular basic military training at the academies. Once their talents were demonstrated, they would be given full opportunity to keep pace with the advance of science by postgraduate work in universities and industry. They would be assigned to the research and development branches of the several services in accordance with proved ability. They would grow within the services, be acquainted with their problems and contribute not only in terms of professional skill, not only in propagating the views of science, but also in linking the scientific and technical activities in universities and industry with the parallel activities of the Armed Services. This is a concept that commends itself to our attention ; it is one on which the U.S. War

Department is most anxious to hear the views and criticisms of industry.

I cannot leave these points without mentioning again the matter of science in education which I referred to before. The future does not belong to us. It belongs to our children and to their children. We must look to them for the future of science. Unless we give them the training, the opportunities, the facilities for turning their talents and their genius into a powerful and disciplined machine, we cannot envisage a bright future for science in America.

It is a heavy assignment of responsibility to say that the future of the United States in peace and in war is to a great extent in the hands of American men of science in industry, in schools, in universities and in government. But I believe the responsibility is properly assigned, and I have confidence it will be met. Vice-President Wallace once stated that science and technology, like good will, have no natural boundaries. The opportunities, the freedom, the security which science can give to our people can be extended to the corners of the earth. By so extending them industry will make its greatest contribution to national security. The perils of war give the precepts of peace. With the help of science and the men and women who make it we shall maintain that peace.

# NATIONAL FLOUR (82½ PER CENT EXTRACTION) AND BREAD

### Sixth Report from the Scientific Adviser's Division, Ministry of Food

ON October 1 last the extraction of National flour in Great Britain was reduced to 82½ per cent. This lowering of the extraction followed work which showed that the bulk of the vitamins and minerals in the wheat grain are located in the germ, particularly the scutellum fraction, and in the outer endosperm adjoining the bran. Provided these two fractions are included in the flour, there will be no appreciable difference in the nutritive value of 82½ per cent as compared with 85 per cent extraction flour. At the same time, the fall in the extraction makes it possible to exclude about 1·6 per cent of bran (on the average, 85 per cent flour contains 4 per cent bran) and so give a whiter flour and bread. Details of the milling technique necessary to produce a satisfactory 82½ per cent flour have been circulated to all millers[1].

## Quality of Flour

Mills were allowed about a fortnight to settle down, after which each mill was instructed to send a 6-lb. sample once a week to the Cereals Research Station, St. Albans, for analyses. These covered colour, fibre, ash, added calcium, iron, vitamin $B_1$, riboflavin and nicotinic acid; in addition, the flours were examined for baking quality.

It was impossible to examine every sample in every respect each week. Thus, the 'colour' of every sample was judged each week; vitamin $B_1$ was determined on samples from all the larger mills every week, and on the remainder once in four weeks, thus covering more than 80 per cent of the total national flour production—on a capacity basis—every week; calcium (as added creta præparata) was determined fortnightly on all samples; fibre and ash were determined on all samples sent by Ministry of Food inspectors, while the remainder of the mills were covered in about eight weeks; about forty flours were baked every week, thus covering all the mills in six or seven weeks. All mills included in the survey were grouped according to their capacity (five groups: up to 5, 6–10, 11–20, 21–50, and more than 50 sacks/hr.) and their port area (London, Bristol, Liverpool, Hull, Leith, Glasgow, and Northern Ireland). Aliquots of samples from all mills in the same capacity-group in each port area were bulked together to form a total of thirty compound samples upon which riboflavin, nicotinic acid and iron were determined fortnightly.

The production of a whitish flour of high nutritive value is a new development, and so the analytical results are given in some detail.

*Colour Index.* Colour (bran speck contamination) was judged on a scale of 0 to 100, where 0 represented a white flour free from visible bran specks, and 100 represented the national average 85 per cent flour (capacity basis) as manufactured during July–September, 1944.

The percentage of all samples examined that fell within the various colour index classes week by week is shown below. The average colour indexes on a mill basis and on a capacity basis are also shown.

| Colour Index not exceeding | Week commencing | *A* Oct. 16 | *B* 23 | *C* 30 | *D* Nov. 6 | *E* 13 | *F* 20 | *G* 27 |
|---|---|---|---|---|---|---|---|---|
| 10 | | 3 | 5 | 4 | 5 | 3 | 2 | 2 |
| 20 | | 5 | 8 | 12 | 19 | 15 | 11 | 15 |
| 30 | | 15 | 21 | 29 | 36 | 29 | 30 | 30 |
| 40 | | 27 | 34 | 42 | 49 | 50 | 48 | 50 |
| 50 | | 46 | 49 | 54 | 66 | 54 | 61 | 62 |
| 60 | | 59 | 65 | 69 | 75 | 68 | 77 | 79 |
| 70 | | 76 | 80 | 79 | 87 | 80 | 85 | 89 |
| 80 | | 85 | 87 | 88 | 91 | 92 | 91 | 94 |
| 90 | | 89 | 92 | 92 | 92 | 93 | 94 | 96 |
| 100 | | 91 | 94 | 94 | 96 | 96 | 97 | 98 |
| Average Colour Index | Mill basis | 59 | 55 | 53 | 47 | 49 | 49 | 47 |
| | Capacity basis | 51 | 45 | 43 | 36 | 38 | 38 | 37 |
| No. of samples | | 226 | 226 | 237 | 246 | 248 | 247 | 254 |

*Vitamin $B_1$.* The percentage distribution of vitamin $B_1$ values and the weekly average vitamin $B_1$ value (mill basis) were as follows:

| $B_1$ (I.U./gm.) | Week commencing | *A* Oct. 16 | *B* 23 | *C* 30 | *D* Nov. 6 | *E* 13 | *F* 20 | *G* 27 |
|---|---|---|---|---|---|---|---|---|
| 1·10 or more | | 2 | 0 | 0 | 0 | 0 | 1 | 0 |
| 1·05 ,, ,, | | 6 | 0 | 0 | 0 | 1 | 2 | 0 |
| 1·00 ,, ,, | | 18 | 3 | 4 | 4 | 4 | 4 | 3 |
| 0·95 ,, ,, | | 38 | 17 | 20 | 11 | 20 | 13 | 11 |
| 0·90 ,, ,, | | 59 | 38 | 43 | 38 | 45 | 38 | 35 |
| 0·85 ,, ,, | | 79 | 65 | 62 | 58 | 68 | 65 | 53 |
| 0·80 ,, ,, | | 91 | 88 | 78 | 84 | 89 | 85 | 78 |
| 0·75 ,, ,, | | 97 | 96 | 90 | 94 | 97 | 95 | 86 |
| 0·70 ,, ,, | | 99 | 97 | 97 | 98 | 99 | 97 | 93 |
| 0·65 ,, ,, | | 100 | 98 | 99 | 100 | 99 | 98 | 96 |
| 0·60 ,, ,, | | | 98 | 99 | | 100 | 99 | 98 |
| 0·55 ,, ,, | | | 100 | 100 | | | 100 | 99 |
| No. of samples | | 99 | 118 | 112 | 117 | 112 | 119 | 130 |
| Mean vitamin $B_1$ value | | 0·92 | 0·87 | 0·87 | 0·86 | 0·88 | 0·87 | 0·85 |
| Per cent of the total milling capacity analysed | | 82 | 84 | 81 | 83 | 81 | 81 | 83 |

The average value for vitamin $B_1$ over weeks *A* to *D* (during which all mills were covered), on a capacity basis, was 0·88 I.U./gm.

*Riboflavin, nicotinic acid and iron.* The average values for these constituents (mill basis) are given in the following table:

| | Fortnight commencing Oct. 16 | Oct. 30 | Nov. 13 | Average for six weeks |
|---|---|---|---|---|
| Riboflavin ($\mu$gm./gm.) | 1·0 | 1·0 | 1·0 | 1·0 |
| Nicotinic acid ($\mu$gm./gm.) | 18 | 18 | 19 | 18 |
| Iron (mgm./100 gm.) | 1·99 | 1·99 | 1·84 | 1·94 |

*Ash and fibre.* The average ash and fibre determinations (mill basis) on samples sent by mill inspectors were as follows:

| Week commencing | *A* Oct. 16 | *B* 23 | *C* 30 | *D* Nov. 6 | *E* and *F* 13 and 20 | *G* Nov. 27 | All samples *A* to *G* |
|---|---|---|---|---|---|---|---|
| Av. ash (per cent) | 0·92 | 0·87 | 0·93 | 0·85 | 0·90 | 0·82 | 0·88* |
| Av. fibre (per cent) | 0·27 | 0·29 | 0·28 | 0·32 | 0·27 | 0·30 | 0·29 |
| Av. fibre (per cent) (corrected for added white flour) | 0·29 | 0·31 | 0·30 | 0·35 | 0·30 | 0·33 | 0·31 |
| No. of samples | 14 | 8 | 11 | 5 | 7 | 11 | 56 |

* Includes 0·12% due to added creta.

*Creta Præparata.* The average value found for the amount of added creta præparata over the last complete month (commencing October 30) was 6·5 oz./sack. The distribution of the figures was as follows:

| Creta (oz./sack) | % of all samples |
|---|---|
| 10 or more | 4·5 |
| 9 ,, ,, | 10·2 |
| 8 ,, ,, | 18·6 |
| 7 ,, ,, | 36·5 |
| 6 ,, ,, | 61·3 |
| 5 ,, ,, | 79·4 |
| 4 ,, ,, | 90·6 |
| 3 ,, ,, | 94·7 |
| 2 ,, ,, | 96·5 |
| 1 ,, ,, | 98·5 |

Hence, 60·8 per cent of all the samples had a value lying between 5·0 and 7·9 oz./sack. This table summarizes the results of analyses on 491 samples of flour.

*Breadmaking quality.* A number of flours were taken at random each week, the object being to cover all mills in due course. These flours were baked in the laboratories under ideal conditions, and the resulting loaves judged for volume, colour and quality of the crumb. The numbers of loaves described as good, fair-good, fair and poor were as follows:

| Quality of loaves | Weeks commencing Oct. 16 | Oct. 23 | Oct. 30 | Nov. 6 | Nov. 13 | Nov. 20 | Nov. 27 | Total for 7 weeks No. of loaves | % of total |
|---|---|---|---|---|---|---|---|---|---|
| Good | 18 | 25 | 29 | 16 | 26 | 31 | 8 | 153 | 62 |
| Fair-good | 12 | 5 | 8 | 4 | 5 | 4 | 2 | 40 | 16 |
| Fair | 8 | 2 | 6 | 3 | 7 | 6 | 3 | 35 | 14 |
| Poor | 7 | 2 | 3 | 1 | 4 | 2 | 1 | 20 | 8 |

Out of the 248 samples of flour examined, 60 (= 24 per cent) showed signs of high maltose due to the inclusion in the grist of sprouted English wheat.

With the fall in extraction from 85 to 82½ per cent, the water absorption of the flour has decreased by ½ gallon per sack. Actually, as shown later, the percentage of Manitoba wheat in the grist has increased from about 40 per cent in the first six months of 1944 to about 57 per cent in October and November. Had the percentage of Manitoba remained at 40 per cent, the water absorption would have decreased by about 1 gallon per sack.

The conversion factor of 82½ per cent flour to bread is approximately 1·33.

*Colour of bread crumb and colour index of flour.* There was a reasonably good relation between colour of bread and colour index of flour as shown in the following table:

| Colour of bread crumb | Mean Colour Index of flours used for baking Oct. 16 | Oct. 23 | Oct. 30 | Nov. 6 | Nov. 13 | Nov. 20 | Nov. 27 | Average for seven weeks | |
|---|---|---|---|---|---|---|---|---|---|
| Very pale | 34 | 41 | 31 | 35 | 36 | 35 | 32 | 35 | (43)* |
| Pale | 57 | 52 | 53 | 37 | 49 | 49 | 64 | 52 | (33) |
| Fairly pale | 97 | 80 | 63 | 65 | 55 | 72 | 73 | 71 | (18) |
| Brownish† | | | 95 | | 95 | 90 | | 92 | (4) |
| Dark brown | | | | | 100+ | 100+ | | 100+ | |

* Figures in brackets are percentages of total number of loaves examined.

† 'Brownish' corresponds to loaf made from average 85 per cent extraction flour.

## Correlation Between Flour Colour and Fibre, and Between Flour Colour and Vitamin $B_1$ Content

*Flour colour and fibre.* All samples analysed for fibre were arranged in groups according to the colour index, and the average fibre content for each group was calculated. There is a close relationship between colour index and fibre content, indicating that the colour index can be used to give a fair estimate of the fibre content.

*Flour colour and vitamin $B_1$ content.* All samples analysed for vitamin $B_1$ during the last complete month (commencing October 30) were similarly arranged in colour-index groups, and the average vitamin $B_1$ content of each group was calculated. Since samples from the large mills (more than 20 sacks/hr.) were analysed each week, the monthly averages for vitamin $B_1$ and colour index were calculated for each mill and these values were used instead of individual determinations. The complete lack of correlation between colour and vitamin $B_1$ indicates that, in general, millers who are getting good colour in their flour are *not* doing so to the detriment of its $B_1$ content. This is to be expected since bran, as such, contributes little to the vitamin $B_1$ content of flour.

| Colour Index | Average fibre content (per cent) | Average vitamin $B_1$ content (I.U./gm.) |
|---|---|---|
| 10 | 0·23 (25)* | 0·88 ( 9)* |
| 20 | 0·24 (15) | 0·86 (29) |
| 30 | 0·24 (19) | 0·87 (47) |
| 40 | 0·27 (14) | 0·86 (41) |
| 50 | 0·28 (20) | 0·88 (34) |
| 60 | 0·31 (26) | 0·86 (35) |
| 70 | 0·33 (27) | 0·85 (29) |
| 80 | 0·34 (28) | 0·88 (16) |
| 90 | 0·36 ( 8) | 0·89 ( 7) |
| 100 | 0·38 (13) | 0·89 ( 5) |
| 100+ | 0·48 (34) | 0·89 ( 9) |

* The number of determinations is shown in parentheses.

## Comparison of 82½ Per Cent Flour with 85 Per Cent Flour

Average figures for 82½ per cent extraction flour as given above are set against figures for 85 per cent flour as given in the 5th Report[2] (covering 85 per cent flour samples received during January–June, 1944).

| | | 82½% flour | | 85% flour | |
|---|---|---|---|---|---|
| Vitamin $B_1$ (I.U./gm.) | (Sample basis) | 0·88 | (807)* | 0·975 | (346)* |
| Riboflavin (μgm./gm.) | ,, | 1·0 | (723) | 1·3 | (346) |
| Nicotinic acid (μgm./gm.) | ,, | 18 | (723) | 17 | (346) |
| Iron (mgm./100 gm.) | ,, | 1·94 | (723) | 2·07 | (346) |
| Protein (per cent) | ,, | 11·6 | (245) | 10·7 | (346) |
| Fibre (per cent) | ,, | 0·31 | ( 56) | 0·50 | (346) |
| Ash (per cent) | ,, | 0·88 | ( 56) | 0·98 | (346) |
| Colour Index | ,, | 51 | (1684) | — | — |
| Colour Index | (capacity basis) | 41 | (1684) | 100 | (200) |

* The values represent averages for the number of samples given in parentheses.

In the report on High Vitamin Flour[1] it was predicted that the lowering of extraction by 2½ per cent would entail a reduction of the bran content of the flour from 4 per cent to 2·4 per cent, and that the 82½ per cent flour would have an average fibre content not exceeding 0·3 per cent. This prediction has been justified in the average figure of 0·29 per cent of fibre (0·31 per cent when corrected for added white flour). This lowering of fibre content is reflected in the lighter colour of the flour. The ash content has also decreased slightly. The vitamin $B_1$ content has dropped rather more than the theoretical prediction of 0·02 I.U./gm., and this, taken in conjunction with the drop in riboflavin content, suggests that some scutellum and embryo are being lost to the offals.

The iron content has shown roughly the forecast decrease of 0·16 mgm./100 gm. On the other hand, the nicotinic acid content, instead of decreasing, has actually increased slightly. The explanation of this anomaly is probably to be found in the composition of the grists used in milling the 85 per cent flour analysed during the first six months of 1944 and those being used for the 82½ per cent flour in October and November. The following table gives details of the grists.

| | Average composition of grist in samples analysed | | | |
|---|---|---|---|---|
| | Manitoba wheat | Home-grown wheat | Other wheat | Barley and rye |
| 85 per cent extraction survey: | | | | |
| January | 37·4 | 59·5 | 0·5 | 2·6 |
| February | 39·7 | 57·3 | 0·5 | 2·5 |
| March | 35·3 | 61·1 | 2·1 | 1·5 |
| April | 38·3 | 58·4 | 2·8 | 0·5 |
| May | 42·7 | 53·2 | 3·6 | 0·5 |
| June | 42·6 | 54·2 | 3·0 | 0·2 |
| 82½ per cent extraction survey: | | | | |
| October 16–30 | 57·0 | 38·1 | 3·8 | 1·1 |
| October 30–November 13 | 57·1 | 38·1 | 3·8 | 1·0 |
| November 13–27 | 57·7 | 37·7 | 3·7 | 0·9 |

The higher Manitoba content of the grist used in making 82½ per cent flour is reflected in the higher protein content of this flour compared with 85 per cent flour.

Further, Manitoba wheat is richer in nicotinic acid than English wheat. An average figure for Manitoba wheat is 60μgm./gm. against 45μgm./gm. for English wheat.

The amount of added white flour during 1944 has varied between 5 and 12½ per cent. The bulk of this flour is Canadian G.R. (fortified with vitamin $B_1$ to a level of approximately 1 I.U./gm.), but small quantities of Plate and, just recently, American fortified flour have also been added. Average figures for this last flour are vitamin $B_1$ 1·5 I.U./gm.; riboflavin 2·7 μgm./gm.; nicotinic acid 36 μgm./gm.; and iron 2·9 mgm./100 gm. It is understood that during the period when the 82½ per cent flour samples were analysed, the overall addition of American enriched flour was well below 2 per cent. Even at 2 per cent level, however, the American flour would only increase the values for 82½ per cent flour by the following amounts: vitamin $B_1$, 0·01 I.U./gm.; riboflavin, 0·03 μgm./gm.; nicotinic acid, 0·4 μgm./gm.; and iron, 0·02 mgm./100 gm. Plate flour and Canadian G.R. flour (except as regards vitamin $B_1$, where it has no effect) would act in the opposite direction.

### Quality of Bread

971 commercial loaves from different parts of Great Britain have been examined during the period October 1–November 30. These were graded for quality (commercial standards) with the following results:

| | | | | | |
|---|---|---|---|---|---|
| Good | = | 98 loaves | = | 10·1 | per cent |
| Fair–Good | = | 427 ,, | = | 44·0 | ,, ,, |
| Fair | = | 266 ,, | = | 27·4 | ,, ,, |
| Poor | = | 180 ,, | = | 18·5 | ,, ,, |

Unfortunately, this harvest was a particularly wet one, and much British home-grown wheat sprouted in the stack. Such wheat has a high maltose content and tends to give a loaf with a doughy crumb. The results, described earlier in this report, showed that some 24 per cent of the flours received from mills gave loaves showing high maltose damage. Of the commercial loaves 298 (= 31 per cent) showed the same defect, and as a result the total percentage of 'Good' and 'Fair–Good' loaves (54 per cent in all) was lower than would otherwise have been the case. There was, however, a marked improvement in the colour of the loaves compared with those made from 85 per cent flour.

This work was carried out at the Cereals Research Station, Ministry of Food, St. Albans.

[1] "High Vitamin Flour" (Ministry of Food, October 1944). cf. also *Milling*, Nov. 4, 1944.
[2] *Nature*, **154**, 582 (1944).

## OBITUARIES

### Prof. C. G. Barkla, F.R.S.

CHARLES GLOVER BARKLA, Nobel Prizeman in Physics for the year 1917, died at his home, Braidwood, Edinburgh, on October 23. The news came as a shock to his friends, for his death occurred rather suddenly. He had been in poor health for some months and had undergone an operation in June. He had, however, recovered from that and was back at work, looking well and seemingly his bright, happy self again, when suddenly he collapsed, was ill for a week and died.

Barkla was the son of John Martin Barkla, a former secretary of the Atlas Chemical Company of Widnes, in which town Charles was born on June 7, 1877. He was educated at the Liverpool Institute, from which he proceeded to University College, Liverpool, where he read for an honours degree in physics. He graduated in 1898 and obtained the master's degree in the following year. In 1899, on the nomination of his College, he was awarded a research scholarship by the Royal Commissioners for the Exhibition of 1851, and went to Cambridge in the autumn of that year, being admitted to Trinity College as an 'advanced student'. He began research work at the Cavendish Laboratory by investigating the velocity of electric waves along wires of various materials and of different thickness. He studied also the absorption of electric waves by dielectrics. The scholarship was in the first instance for two years, but Barkla's tenure was exceptionally renewed for a third year. It was during this additional year that he commenced his investigations of secondary X-radiation, and so entered the field of research work with which his name will always be associated.

After one year at Trinity, Barkla migrated to King's College. He possessed a powerful baritone voice and during his first year at Cambridge had contemplated the delight of singing in the choir of a chapel of the size and magnificence of King's. Dr. Mann, the organist of King's, encouraged the migration, and Barkla became a member of King's College choir and a regular attendant both at practices and services. His magnificent singing added to the reputation of the College chapel in that respect, and, in his last year at Cambridge, if it became known that Mr. Barkla was to sing the solo part in an anthem, the great chapel of King's was crowded for the occasion.

On leaving Cambridge in 1902, Barkla was elected to the Oliver Lodge fellowship of the University of Liverpool, which he held for three years, continuing his researches on X-rays. During the period 1905–9 he was successively demonstrator, assistant lecturer in physics and special lecturer in advanced electricity at the University. He was then appointed to the Wheatstone chair of physics in the University of London (King's College) in succession to H. A. Wilson, who was leaving to succeed Rutherford at Montreal.

The Royal Society elected Barkla to its fellowship in 1912, and in the following year he accepted the professorship of natural philosophy in the University of Edinburgh, which he held until his death.

During the most active period of his life, Barkla's investigations dealt mainly with X-rays and their absorption by matter, and with the emission of secondary radiation. He was the first to show that the secondary emission is of two kinds, one consisting of X-rays scattered unchanged in quality, and the other a 'fluorescent radiation', characteristic of the scattering substance and accompanied by selective absorption of the primary beam. The secondary radiation of the first kind Barkla showed to be polarized, an experimental result of fundamental importance, for it indicated that X-radiation was to be regarded as similar to ordinary light, a point which, up to that time, was thought to be doubtful.

For the discovery of the characteristic radiation and for the explanation of its origin Barkla was most deservedly awarded the Nobel Prize for Physics in the year 1917. His outstanding achievements were also recognized by the Royal Society, which appointed him Bakerian Lecturer for 1916 and awarded him the Hughes Medal in the following year.

Barkla was a successful teacher who inspired many of his pupils with an enthusiasm for research. He was in great request as an examiner in physics, and few excelled him at this work. His long experience of students in three universities, the wide range of his knowledge of physics, his judgment and common sense made him an eminently fair and discriminating examiner. He would re-read with extreme patience (not always shared by his co-examiner) any script of a 'border-line' candidate which he found difficult to assess, and his verdict, when finally delivered, could be accepted with confidence.

While a lecturer at Liverpool, Barkla married Mary Esther, eldest daughter of the late John T. Cowell, receiver-general of the Isle of Man. He leaves two sons and a daughter. Only in the last year was his life clouded by indifferent health; but the family had previously suffered a grievous loss by the death at Carthage in August 1943 of the youngest son, Flight-Lieutenant Michael Barkla, whose achievements at school and at the university had given promise of a career no less brilliant than that of his distinguished father.

Those who were privileged to know Barkla well will treasure the memory of his open-hearted friendliness and personal charm, of the delights of the Hermitage of Braid—his earlier home in Edinburgh—and of the almost idyllic happiness of his domestic life there.

FRANK HORTON.

## Prof. G. D. Birkhoff

THE many friends of Prof. G. D. Birkhoff on the eastern side of the Atlantic are deeply grieved to hear of his death on November 12. For a whole generation he had been a commanding figure among mathematicians and a link between American men of science and their colleagues in both western and eastern Europe.

George David Birkhoff was born at Overisel, Michigan, on March 21, 1884; as the name would indicate, his family was originally Dutch, but it has long been settled in the United States. He studied first at Chicago and then at Harvard, returning to Chicago for his doctorate; and, after a short period as instructor in the University of Wisconsin, was appointed assistant professor of mathematics at Princeton in 1909. It was here that he wrote the memoir on the "General Theory of Linear Difference Equations" (*Trans. Amer. Math. Soc.*, 1911) which first brought him into prominence; the "Jahrbuch über die Fortschritte der Mathematik" devoted more than two pages to a notice of it, a rare honour for a young and unknown author. Fundamental solutions of linear difference equations with rational coefficients were obtained for the entire plane of the complex variable by direct matrix methods, and their nature was studied from the functional point of view. Birkhoff showed that there exists a purely Riemannian theory of the equations, and found quantities which play a part like that of the monodromic group constants of an ordinary linear differential equation. His methods were of wide generality, and the paper constituted a striking advance in the subject, to which he made further contributions from time to time, notably in a memoir in *Acta Math.*, 54 (1930).

A closely related branch of mathematics which also owes much to Birkhoff is the theory of linear differential equations, on which he published many memoirs from 1910 onwards (*Proc. Amer. Acad.* and *Trans. Amer. Math. Soc.*); the earlier ones were particularly concerned with the problem of constructing systems of linear differential equations with prescribed singular points of given character and with a given monodromic group.

Birkhoff's interests were shared between pure and applied mathematics, and his work in dynamics was of great value. In an extensive memoir—almost a complete treatise—on "Dynamical Systems with Two Degrees of Freedom" (*Trans. Amer. Math. Soc.*, **18**; 1917), he reduced all problems relating to such systems, even in the 'irreversible' case, to the problem of determining the orbits of a particle constrained to move on a smooth surface which rotates about a fixed axis with uniform angular velocity and which carries with it a conservative field of force; and he showed how the existence of periodic solutions may be directly inferred, and their form determined. This investigation was followed by others, especially on periodic orbits and the problem of three bodies (*Acta Math.*, *Amer. J. Math.* and elsewhere); a connected account of much of his dynamical work appeared in 1927 as one of the American Mathematical Society's Colloquium volumes, under the title "Dynamical Systems".

His two books on relativity, "Relativity and Modern Physics" (1923) and "The Origin, Nature, and Influence of Relativity" (1925) were useful and widely read, and characteristically original in treatment.

In later life, Birkhoff became much occupied with the discovery of mathematical relations in æsthetics. As is well known, more than two thousand years ago Pythagoras founded the scientific theory of music by showing that simple numerical ratios exist between the lengths of the strings the notes of which yield agreeable melodic progressions. Birkhoff's aim was to create a theory of similar character for the fine arts: the results obtained were described in his book "Aesthetic Measure", published in 1933.

Birkhoff was professor of mathematics in Harvard University from 1919 onwards, president of the American Mathematical Society during 1924–26, president of the American Association for the Advancement of Science during 1936–37; an honorary doctor of many American universities and of St. Andrews, Poitiers, Paris, Athens and Sofia;

a foreign member of many European academies (including the Institut de France, the Lincei and the Pontifical Academy) and mathematical societies, and an Officier de la Legion d'honneur. His last years were gladdened by the knowledge that his brilliant son Garrett was steadily advancing towards a position in the world of mathematics not inferior to his own.

E. T. WHITTAKER.

## Dr. O. F. Bloch

OLAF BLOCH was a man of remarkable energy largely applied to the progress of photographic science and in furthering the application of photography as a tool in many branches of science and technology. He received his earliest scientific training at the Finsbury Technical Institute under Prof. H. E. Armstrong, and having spent some years in the Davy Faraday Laboratory and in chemical manufacture, he joined the staff of Ilford, Ltd., in 1910. Little can be written of his very successful work over many years to produce improved light-sensitive materials, for much of it was made known only to his closest associates and publication in this field is rare; but mention may be made of important work with F. F. Renwick on the optical properties of photographic layers, and early attempts, with Miss F. M. Hamer, to relate the chemical structure of cyanine dyes with their sensitizing properties.

As secretary of the Scientific and Technical Group of the Royal Photographic Society in the years following the War of 1914–18, Bloch took a leading part in organizing an attack on the problem of the sensitometric testing of photographic materials, leading to recommendations to the Sixth International Congress of Photography in Paris in 1925.

Bloch became chief chemist of Ilford, Ltd., in 1930, and his devoted work for the Royal Photographic Society was recognized by his election to the presidency in the following year. His ready wit and wide knowledge made him a most popular lecturer, and he addressed many of the learned societies in Great Britain. He will be particularly remembered for his accounts of the many applications of infra-red photography, just then made really practicable by the discovery and application of thiatricarbocyanines. Later he turned to demonstrating the importance of photography as an indispensable tool in many branches of science and industry, and in these lectures Bloch referred always to his conviction that photography is grossly neglected by British universities as a subject for teaching and research. The foundation of a chair of photographic science at a university in Britain was a cause very dear to him, so that he found particular pleasure in helping academic scientific workers in their photographic problems. Thus by collaboration with Dr. F. W. Aston he produced plates especially designed for recording atomic particles of low penetration, and these were used in the classical investigation of isotopes. A range of materials of special characteristics and spectral sensitivities was prepared for use in astronomy and related sciences. More recently, Bloch eagerly accepted opportunities to collaborate with atomic physicists to evolve photographic emulsion layers of value in recording tracks produced by penetrating atomic particles.

These and other services to scientific investigation were recognized by the University of Aberdeen by the award of the honorary degree of LL.D. He received the Progress Medal of the Royal Photographic Society, and, appropriately, was chosen to preside at the commemoration of the centenary of photography at the Royal Society of Arts in 1939.

Away from his work, Bloch had a remarkable range of interests; he was deeply appreciative of literature and the arts, and was a keen gardener with an encyclopædic knowledge of garden plants. Taking up alpine mountaineering with characteristic enthusiasm when more than fifty years old, he qualified for membership of the Alpine Club. He died on October 19 at the age of seventy-two years.

C. WALLER.

WE regret to announce the following deaths:

Sir John Fox, C.B., O.B.E., F.R.S., Government chemist, on November 28, aged seventy.

Sir Percy Nunn, first director of the Institute of Education, University of London, on December 12, aged seventy-four.

# NEWS and VIEWS

## Ethics of Scientific Investigation

IN his address "Human Nature in Science" to the Section on Geology and Geography of the American Association for the Advancement of Science, delivered at Cleveland on September 13, 1944 (*Science*, **100**, 299; 1944), Dr. J. K. Wright gave a highly stimulating discussion of some relations between human nature and science as they might be set forth in such a manual for science as Macchiavelli wrote for princes. Analysing first the personal qualities that influence scientific research, especially originality, open-mindedness, precision and scientific consciousness or the ability to discriminate between motives, Dr. Wright indicates the dangers which may attend excess of any one of these qualities. He surveyed next the motives for scientific research; these are first classified as pro-scientific, anti-scientific or non-scientific, according to whether they promote, retard or have no effect on the advancement of science; and again as personal, group or disinterested motives, depending on whether they spring from a desire to serve individual, group or no particular interests. In this analysis, Dr. Wright has wise and stimulating words about opinions or judgments of the relative worth of scientific investigations. Qualitative judgments are fairer than formal judgments, for they take account of the degree of good sense, originality, accuracy and open-mindedness to which the study bears witness, as well as of the suitability of the form and substance to the solution of the problem in hand. The preliminary work required before scientific laws can be formulated may be quite as scientific as the subsequent processes of interpretation to which it leads; and an economic law may be fully as scientific as the law of eclipses, provided all available evidence is used in developing the economic law—and used with the same degree of rationality as that attained in developing the astronomical law.

With regard to pragmatic opinions which rate scientific researches in terms of their effects, incomplete and even earlier studies of little understood but important phenomena may have more far-reaching and beneficial effects than studies of higher quality that deal either with inconsequential matters or with matters already well understood in their essentials. Great works of compilation may be rated very high from the pragmatic point of view, because of the many practical purposes they serve and the stimulus they furnish for the development of scientific theories. Pragmatic opinions also largely fashion the response of the scientific worker to group motives, and here Dr. Wright stresses obstacles which anti-scientific practices arising from such motives offer to the advancement of science. Three types are indicated: the wilful distortion of truth to mislead rival groups; suppression of the results of scientific research to prevent rivals benefiting by them; and use, as in war, of the results of scientific research to injure rival groups. Ethics and science, he holds, are inextricably linked, and unethical practices are not only anti-social but also anti-scientific. Again, he urges that the advancement of science demands the continuous discovery of new truths and the continuous development of new hypotheses, for which the fullest and freest possible interchange of knowledge is prerequisite. Dealing briefly in conclusion with the effects of war on science and with the reconstruction of scientific endeavour after the War, Dr. Wright admits that war may lead to rapid advances along certain specific lines of research, but suggests that the transition problems may be even more difficult than those in waging war itself. He urges concentrated effort to forestall the loss or destruction of the masses of information accumulated for war-time purposes.

## Incentives in Industry

IN an address to the Leicester Centre of the Institute of Industrial Administration on "Incentives for Indirect Workers" (*J. Inst. Indust. Admin.*, 5, 14; 1944), Mr. Harold White gives an interesting analysis of the incentives affecting workers not directly engaged in manufacturing processes or the assembly or finishing of products. After discussing the characteristic features of the indirect worker's job, he indicates seven types of incentive—particular interest in the type of work, personal pride in the apparent importance of the position held, increase in rate of pay, opportunities for promotion, bonuses based on earnings of direct workers, *ex gratia* bonuses, and permanency of position—the effectiveness of which depends largely on the intelligence and ambition of the individual and the general nature of his job. Factors on which actual bonus schemes have been based are next considered, and Mr. Whitehead's review of these schemes leads him to six conclusions, as follow. The big majority had proved sufficiently satisfactory to be considered a permanent feature of the company's policy. The more direct the bonus to the indirect worker, the better the response. Confidence in the management is essential to the success of a scheme. 'Ready-made' schemes are dangerous; no standard programme of incentives can be laid down for adoption without studying and evaluating internal circumstances. An incentive plan for indirect workers cannot be established by intuition: it demands thorough and careful forethought. The probable results, in cash, to the indirect workers must be fully considered, so that the probable amount is a real incentive, and not merely a financial liability to the company.

## Science in Post-Primary Education

AN interim report has recently been compiled by the Association of Women Science Teachers with the view of submitting a scheme for the teaching of science in the post-primary schools of the future (An Interim Report of a Sub-Committee of the Association of Women Science Teachers. Pp. vi+22. London: John Murray, 1944. 1*s.* 3*d.* net). The sub-committee which submitted this report considers the needs of all types of children within the secondary school range, dealing fully with the ideals that should permeate the science teaching and with the need for a change of outlook. Although the present publication outlines full syllabuses for children of eleven to sixteen years only, a subsequent publication, already in preparation, will also contain chapters on sixth form science, part-time education in science, the training of teachers and administrative problems. A useful chapter on laboratories and equipment, the museum, first aid, organization of department and other matters will be appended.

The five-year course of general science suggested is based on the fundamental principles of social relationships; selection from the syllabuses, by the teacher, will be necessary, as these syllabuses are thought to contain the maximum for children of the highest intelligence, given the best opportunity. For the first two years, the topics considered are the universe and its attributes of light, heat and gravitation, water, air, land and people; for the last three years those of energy, matter and life. Methods of presentation are discussed and time allowances for science recommended. A progressive outlook has produced syllabuses that are less academic than usual, although the experimental and objective attitude to problems is regarded throughout as of paramount importance.

## Royal Institution

DR. L. R. G. TRELOAR delivered a discourse at the Royal Institution on December 15, speaking on "Rubbers and their Characteristics: Real and Ideal". He pointed out that although rubbers are diverse in chemical constitution, they all conform to a general type of molecular structure, and it is in this structure that the origin of the remarkable physical properties of rubbers is to be found. All rubbers are built up of enormously long chain-like molecules which are linked together so as to form a loose three-dimensional network. The atoms of the molecular chain are in a state of continuous motion, due to their thermal energy; hence the molecule tends to take up a randomly-kinked, continuously fluctuating form, in which its effective length is only a small fraction of the full chain-length. As a result, the molecule exhibits elasticity. The elasticity of rubbers, like that of gases, is thus kinetic in origin. Rubber-like elasticity is always limited to a certain range of temperature, varying with the chemical constitution of the molecule. At low temperature, rubbers are transformed to a glass-hard condition, whereas at high temperatures they tend to lose strength and to approach the condition of a highly viscous liquid. In some rubbers, also, a crystalline state is possible. Crystallization develops slowly in

natural rubber at low temperatures, but it may be produced almost instantaneously by stretching at normal temperatures. Crystallization profoundly affects the physical properties of rubber, and its study has had an important bearing on the elucidation of its molecular structure.

### White Rainbow at Malvern

AN account of a white rainbow has been received from Mr. R. H. Stevens of "Rockland", Cowleigh Road, Malvern. The bow was seen at about 10.30 a.m. on November 8 after a short snowstorm, but no snow could be seen to be falling at the time of the observation. The white rainbow, also known as the 'fog-bow' or 'Ulloas Ring', is a rare phenomenon due, as in the case of the ordinary coloured rainbow, to refraction and reflexion of sunlight in falling drops of rain, but the raindrops composing the cloud must be very small—0·1 mm. or less in diameter. When this is the case, the first maxima of intensity for the different colours of the spectrum are spread out over a wider angle than with the larger drops, and are nearly coincident, the result being approximately to restore the original colour of the sunlight. The bow is only bright enough to be visible in exceptionally favourable circumstances and when the observer is near the cloud which contains the small drops. In this instance the previous occurrence of snow must be assumed to have been fortuitous, the snow probably having originated from clouds at a higher level than that of the cloud which carried the water drops.

### Recent Earthquakes

DURING August 1944, five strong earthquakes were registered by the seismographs at the Dominion Observatory, Wellington, New Zealand. The first of these, on August 8, from an estimated epicentral distance from Wellington of a little more than 48°, had a depth of focus near 80 km. Those of August 15, 25 and 30 all had a depth of focus near 100 km. In addition, thirteen earthquakes and tremors originated in or near New Zealand during the month and were felt by people in the Dominion. The strongest of these, on August 16, was felt with intensity 5 on the modified Mercalli scale in the region of Kahurangi Point. Others with intensity 4 were in the southern part of North Island on August 14; on the west coast of the North Island—Wanganui—Wellington, on August 17; and in the Wairarapa and north Wellington region on August 26.

The United States Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association has determined the provisional epicentres of three earthquakes on September 23, October 2 and 6. The earthquake of September 23, which took place about 12h. 13·3m. G.M.T., had its epicentre near lat. 53·5° N., long. 160·7° E., which is in the Kamchatka Peninsula. It was reported as registered by fourteen seismological stations. The earthquake of October 2 at 17h. 21·9m. G.M.T. had its epicentre near lat. 14·5° N., long. 90·1° W., which is in Guatemala. The shock of October 6 at 2h. 34·7m. G.M.T. occurred at lat. 39° N., long. 27° E., which is in Turkey. The earthquakes of September 23 and October 6 were registered by Mr. E. W. Pollard at his observatory at Binstead, Isle of Wight. Between August 2 and October 31, Mr. Pollard's home-made apparatus registered twenty-three earthquakes and tremors, mostly from large distances.

Recordings for the period October, November and December 1943 have just been received from Suva, Fiji. Altogether thirty-seven earthquakes were registered during the period. These registrations are most useful when taken in conjunction with those of New Zealand, Australia and America.

### Scientific Literature for Liberated Europe

AN appeal, signed by Sir William Beveridge, Prof. P. M. S. Blackett, Mr. E. Carter, Mr. J. G. Crowther, Dr. C. D. Darlington and Sir Richard Gregory, has been issued for literature dealing with advances made in Allied Countries during the War for dispatch to liberated Europe. In particular, French men of science need this material as quickly as possible. In Paris, there is gas and electricity for only one or two hours in the evenings, so that experimental work is scarcely possible. All material sent to France would be fully used. Literature would go to the Centre National de Recherche Scientifique in Paris, which is in touch with the whole body of French scientific workers. Single copies would be microfilmed, and films and abstracts distributed. Thus the greatest possible use could be made immediately of any periodicals that can be sent to them. Sets of journals and single copies should be sent to the Association of Scientific Workers, Hanover House, 73 High Holborn, London, W.C.1.

### Conference on the Place of Science in Industry

THE Division for Social and International Relations of Science of the British Association is arranging a conference on "The Place of Science in Industry" to be held on January 12 and 13 at the Royal Institution, Albemarle Street, London, W.1. The conference will be opened by Sir Richard Gregory, president of the Association, and there will be four sessions, at which the chair will be taken respectively by Mr. Ernest Bevin, Lord McGowan, Sir John Greenly and Lord Woolton. The subjects of the sessions will be: what industry owes to science, fundamental research in relation to industry, industrial research and development, and the future—what science might accomplish. A limited number of tickets will be available for the public other than members of the Association, and may be applied for at the office of the British Association, Burlington House, London, W.1.

### Announcements

DR. SIDNEY E. SMITH, who recently resigned from the presidency of the University of Manitoba to take up the appointment of principal of University College, Toronto, and executive assistant to the president of the University of Toronto, the Rev. H. J. Cody, will succeed Dr. Cody as president on July 1, 1945.

THE Langley Memorial Prize, value £21, is open to competition among officers of the Colonial Medical Service who are serving, or who have served, in West Africa. The prize will be awarded for a paper on (a) tropical medicine or surgery; (b) tropical hygiene and sanitation; or (c) tropical entomology and parasitology. Papers, which may consist of either published or unpublished work, should be delivered to the Secretary, London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, not later than October 1, 1945.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## Penicillin in Yaws and Tropical Ulcer

PENICILLIN has not, up to the present, been extensively employed in tropical medicine. There is, however, evidence that, among other conditions, penicillin has an action in syphilis[1,2], on *Spirochœta recurrentis* infections in mice and on *Spirillum minus*[3] as well as possibly on *Leptospira icterohœmorrhagiœ*[4]. Evidence which is here presented shows that penicillin is of value in yaws and tropical ulcers, which form two of the greatest problems in tropical medicine. Ulcers during the present year, 1944, have, for example, been responsible for the loss of 30,000 men-days among West African troops.

A total of twenty-four cases of yaws in children has now been treated; two were primary, the remainder secondary. 50,000–100,000 Oxford Units have been injected intramuscularly over 12–24 hours. The results are dramatic, and nineteen cases were clinically cured in an average time of 6½ days.

In the two cases of primary yaws, complete cure with reversal of the Kahn test was effected within 7 days. In the secondary cases, the 'snuffles' disappeared, the papules desquamated and the typical yaw dried up and lost its yellow colour within 24 hours. Afterwards, within 2 to 10 days scabs had fallen off and the only stigmata of secondary infection were white or grey-brown scarred areas.

In one case where a severe bismuth stomatitis had developed in a child following 1·5 grains of 'Sobita', penicillin produced a rapid cure both of the yaws and the stomatitis within 48 hours.

Typical cases are as follows:

*Case* 11. *Akusa.* Female. Aged 9 months. Achimota Village. A case of large primary yaw involving almost the whole of the sole of the left foot. Kahn and Ide tests both positive. 100,000 units of sodium penicillin given over 24 hours, and penicillin ointment applied to sole. After 2 days the primary had decreased in size and was drying up. After 6 days the foot was healed. Kahn and Ide negative. The foot was re-examined after 15 days and was found to be perfectly healed; no secondary rash.

*Case* 17. *Fahti.* Female. Aged 12 years. Fulani Zongo Village. Primary lesion on left knee six months ago, which was still present: has had generalized papular rash for 4 months. Kahn and Ide tests both positive. 100,000 units of sodium penicillin given over 12 hours. Within 24 hours, distinct flattening of some of the papules, and in others early desquamation. After 10 days, site of papules denoted only by areas of hyperpigmentation and the primary site by a grey-brown scar. Kahn and Ide positive.

*Case* 18. *Owudu.* Male. Aged 2½ years. Fulani Zongo Village. Primary lesion on inner border of right thigh, 8 months ago. This was still present. Multiple secondary lesions for the last six months, the main sites being chin and neck, abdomen, perineum and occiput. Also had a running nose. Ide test positive. Spirochætes demonstrated from the yaw in large numbers. 100,000 units of sodium penicillin over 12 hours intramuscularly. Within 24 hours the primary lesion had dried up, and presented a pink glazed appearance and the snuffles had ceased. Within 48 hours, all yaws showed thinning and shrinking of their crusts, darkening and complete disappearance of the typical yellow colour, the whole giving an appearance as if the scab had been desiccated. Some lesions already showed separation at the periphery. By 5 days, all yaws had disappeared, leaving either a pale fairly sound skin at the site of the lesion, or a grey brown leathery surface. By 10 days there was no evidence of active yaws, and the only stigmata left were areas of scarring denoting the site of the original lesions. Ide test still positive after 21 days.

The serology has been followed up in all cases, though complete results are not yet to hand. In the two cases of primary yaws treated, healing, with complete reversal of Kahn, has been accomplished within seven days. In two cases of secondary yaws observed over six weeks, the Kahn and Ide tests have not been reversed.

The reversal of the Kahn test is in fact an academic point, for the main object of any mass treatment of yaws is to cause cessation of the active infection. The indications are, however, in the light of the work of Wise and Pillsbury on syphilis, that larger doses of from half to one million units would effect the reversal of the serological tests. With larger supplies of penicillin available it is hoped to employ bigger dosage. Even with the small doses at present used, the disappearance of lesions is far more rapid than with 'Sobita'. There have been no toxic results even in quite young and very under-nourished children or in the nine cases where calcium penicillin was used intramuscularly.

Thus since *Spirochœta pertenue* is apparently also among the organisms susceptible to penicillin, it was decided to employ penicillin in phagædenic tropical ulcers, in which spirochætes and fusiform bacilli are present together with other organisms.

Many of the ulcers had been in existence for periods up to one year. A total of 35 cases has been treated, and six have healed completely within 7–35 days, while the rest, still under surveillance, are in process of healing. Here again, 100,000 Oxford Units were injected in twenty-four hours and penicillin ointment (250 units per gram) was applied, or penicillin ointment alone locally was used. Within forty-eight hours, there is a marked reduction in the pus, with disappearance of smell and rapid formation of granulation tissue in the base of the ulcer and a blue line of commencing epithelization at the edge. The œdema subsides; the surrounding hyperpigmentation of the skin also tends to disappear. The subsequent course of events is a rapid surface epithelization of the edges with filling up of the base of the ulcer with granulations. Within a few days the ulcer becomes sterile or shows only scanty organisms (occasionally spirochætes only), though in five cases *Ps. pyocyanea* has been found to be present but with no apparent inhibition of healing. Better results are obtained by a combination of local treatment and parenteral injection than local treatment alone.

Typical cases:

*Case* 2. *Adisah.* Female. Aged 30 years. Fulani Zongo Village. Large ulcer 5 cm. × 2 cm. and 1 cm. deep, with a chronic rolled edge of one year's duration. Spirochætes, fusiform, vibrios, staphylococci and anaerobic streptococci in the pus. Calcium penicillin ointment applied daily through the treatment. Within 48 hours, the edge was sodden and white coloured. In 3 days, the white detritus at the edge had been replaced by a blue line of epithelium, while the base was filling up with granulation tissue. By 7 days the cavity was nearly filled with a clean red granulation tissue and *Ps. pyocyanea* was cultured. At 21 days there was a central core of granulation 3 cm. × 1 cm. surrounded by a zone of soft white scar tissue. 24 days, almost healed, central area covered by a pink shiny epithelium.

*Case* 14. *Ghartey.* Male. Aged 10 years. Winneba. Ulcer on left internal malleolus 0·5 cm. in diameter, of one month duration. Smear and culture, fusiform bacilli and spirochætes, virios and anaerobic streptococci. Calcium penicillin was applied for 3 days only. After 7 days a blue line of epithelium had extended 0·5 cm. from the edge. Smear showed no organisms. Examined at 28 days—had been away from hospital with original dressing for three weeks. Despite this, only small central granulations were present about 2 mm. in diameter. Smear showed fusiforms and spirochætes. Penicillin ointment re-applied and within another 7 days the ulcer healed.

*Case* 15. *Kwasi Bentum.* Female. Aged 5 years. Winneba. Foul-smelling saucer-shaped ulcer of the right arm, 10 cm. × 5 cm., of 9 days duration; showed grey-green membrane with hæmorrhages. Smear and culture yielded fusiforms, spirochætes, vibrios and anaerobic streptococci. 100,000 units of sodium penicillin were given over 12 hours intramuscularly. After 24 hours the smell had gone, the edges flattened and the base of the ulcer cleaner though still unhealthy-looking; after 5 days, ulcer closing rapidly due to advancing epithelization from the edges. 15 days healed; 22 days, sound scar.

Two severe cases of cancrum oris in children have been treated; in both cases the lesions rapidly cleared both clinically and bacteriologically; one small boy suffering from extreme marasmus and

vitamin B complex deficiency unfortunately died a fortnight after the local condition had healed; the other patient recovered.

The impression has been gained that penicillin treatment gives the initial impetus to healing of phagædenic ulcers of several months duration; once healing has started, the subsequent course of events is controlled by the nutrition of the patient. It is to be noted that all our cases were ambulatory and all were under-nourished.

G. M. FINDLAY.
K. R. HILL.
A. MACPHERSON.

General Headquarters,
West Africa Force,
Accra, Gold Coast.

[1] Mahoney, J. F., Arnold, R. C., and Harris, A., *Amer. J. Pub. Hlth.*, **33**, 1387 (1943).
[2] Wise, E. R., and Pillsbury, D. M., *Proc. Roy. Soc. Med.*, Section of Medicine, **30**, 11 (1944).
[3] Lourie, E. M., and Collier, H. O. J., *Ann. Trop. Med. and Parasitol.*, **37**, 200 (1943).
[4] Herrell, W. E., Nichols, D. R., and Heilman, D. H., *J. Amer. Med. Assoc.*, **125**, 1003 (1944).

## Bacteriostatic Action of Sulphonamide Derivatives

WE have confirmed and extended the observations of L. K. Wolff and H. W. Julius (1939) that sulphanilamide acts on bacteria only when they are multiplying, that is, in the logarithmic phase of their growth. Taking into consideration the physicochemical changes which are apparent in the environment of bacteria rapidly subdividing, more especially the rapid fall in potential which accompanies multiplication, we have looked for a reducing agent and have found that about the time when the sulphonamides begin to act *in vitro* a substance is produced which gives the *o*-dinitrobenzene test applied by Fearon and Kawerau (1943) to the recognition of dienol compounds. This substance is of the nature of, and may be identical with, reductone.

Reductone readily condenses with *p*-aminobenzoic acid, sulphanilamide, sulphapyridine and sulphathiazole to form coloured compounds. We have isolated these compounds in crystalline form by adding the appropriate aminobenzene derivative to solutions of glucose which have been heated with alkali and then made acid according to the method used by H. von Euler and co-workers (1933) for the preparation of reductone. On account of its solubility, the sulphanilamide - reductone compound has not yet been obtained pure; but the other derivatives have been separated completely from the added aminobenzene compound.

From a study of the properties of these reductone derivatives, we have arrived at certain conclusions as to the role of *p*-aminobenzoic acid in bacterial metabolism and the way in which it is supplanted by the sulphonamides. The *p*-aminobenzoic acid - reductone compound goes into solution readily at a *p*H of 7·5–8·0, giving a yellow solution in which it undergoes rapid hydrolysis, even at room temperature, setting free *p*-aminobenzoic acid and reductone. When completely hydrolysed the solution is colourless. The sulphapyridine and sulphathiazole compounds are much less soluble than the *p*-aminobenzoic acid compound, and hydrolyse slowly and incompletely. From these and other observations it is concluded that the function of *p*-aminobenzoic acid in bacterial metabolism is to condense with, stabilize and temporarily immobilize prior to utilization, reductone or compounds of the reductone type which play an essential part in the chain of metabolic reactions and which, without such stabilization, would, by reason of their reactivity, be either lost to the bacterial cell or toxic to it. If compounds of the sulphonamide type be presented to the cell, they compete with *p*-aminobenzoic acid for the reductone produced during metabolism, and form with it compounds which are not available for use by the micro-organism.

In support of this view the following are some of the experimental results which we have obtained:

(1) Growth of streptococci has been observed on supplying the *p*-aminobenzoic acid - reductone compound to a medium, deficient in energy sources, which otherwise failed to give growth.

(2) No growth has been observed when the sulphapyridine - and sulphathiazole - reductone compounds have been substituted in the above experiment.

(3) Bacteria can be shown to assimilate added *p*-aminobenzoic acid from their environment, especially during the most active phase of growth. At a later stage of growth they return it once more to the surrounding medium.

(4) Bacteria also assimilate and later liberate added sulphanilamide, sulphapyridine and sulphathiazole, but not so rapidly.

Full details of this work will be published elsewhere later.

R. A. Q. O'MEARA.
P. A. MCNALLY.
H. G. NELSON.

School of Pathology,
Trinity College,
Dublin.
Nov. 4.

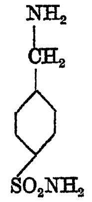
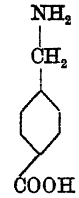
## Mode of Action of Benzylamine Sulphonamide ('Marfanil')

THE antibacterial agent benzylamine-4-sulphonamide (I), which under the name of 'Marfanil' was supplied in quantity to Rommel's forces in North Africa, has given interesting results in Allied hands (cf. Mitchell, Rees and Robinson[1]). Organisms made resistant to sulphanilamide by growing them in contact with the drug were resistant to all other sulphonamides except 'Marfanil'[2]. Schreuss found that the antibacterial action of 'Marfanil' was not antagonized by *p*-aminobenzoic acid[3]. A possible reason for these differences from the sulphanilamide-like drugs is revealed by the determination of the basic strength.

Benzylamine sulphonamide, having the amino-group insulated from the benzene nucleus by a methylene group, should be a much stronger base than sulphanilamide and *p*-aminobenzoic acid, which were found to be very weak bases[4]. Following the procedure outlined in the previous communication[4], the negative log of the acidity constant ($pKa$) expressing the position of the equilibrium of the reaction

$$BH \rightleftharpoons B + H^+$$

(where $B$ represents the base) was determined by potentiometric titration with the glass electrode in water at 20° C. (see table). Benzylamine-4-carboxylic acid (II), which stands in the same structural relationship to benzylamine sulphonamide as *p*-aminobenzoic acid does to sulphanilamide, was investigated also.

(I)  (II) 

If the forces between enzyme and metabolite or drug are electrical in nature, then similarly charged ions are overwhelmingly best fitted to compete with one another for the enzyme. However, the fact that substances with both acid and basic groups exist in solution as an equilibrium mixture of the four different electrical forms, in the proportion determined by the $p$H and the $p$K$a$, would render all substances in the accompanying table capable of competing with one another to some extent; but when a substance intended to displace an essential metabolite from an enzyme is mainly in a different electrical form from the metabolite, then the concentration required for its action may be so high as to exclude its use as a drug.

| Substance | $p$K$a$ (basic group) | $p$K$a$ (acid group) | Principal ionic form at $p$H 7·3 |
|---|---|---|---|
| Benzylamine-4-sulphonamide (I) | 8·18 | 10·23 | cationic |
| Benzylamine-4-carboxylic acid (II) | 9·64 | 3·59 | zwitterionic |
| Sulphanilamide (for comparison) | 2·1 | 10·3 | unionized |
| $p$-Aminobenzoic acid (for comparison) | 2·2 | 4·9 | anionic |

Applying the Mass-Law equation

$$p\text{H} - p\text{K}a = \log \frac{[B]}{[BH^+]},$$

one deduces that, at the physiological $p$H value (7·3), benzylamine sulphonamide exists mainly in the form of positive ions, whereas sulphanilamide exists as uncharged molecules plus a small proportion (0·1 per cent) of negative ions (this proportion increasing as the potency of sulphanilamide is increased by substitution, as in sulphathiazole and sulphadiazine[5]). Similarly, $p$-aminobenzoic acid exists mainly as negatively charged ions. Thus it is unlikely that benzylamine sulphonamide can compete effectively for the same position on the enzyme surface as the oppositely charged $p$-aminobenzoic acid.

Accordingly, it is postulated that benzylamine sulphonamide acts on a different enzyme from that involving $p$-aminobenzoic acid. Whether benzylamine-4-carboxylic acid can antagonize the antibacterial action of benzylamine sulphonamide remains to be determined. This possibility is not excluded by the above results, but it will depend, of course, on whether benzylamine-4-carboxylic acid is an essential metabolite, as demanded by the Woods-Fildes theory.

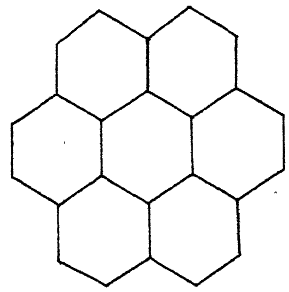
The benzylamine-4-sulphonamide was prepared by Prof. A. K. Macbeth, University of Adelaide, and the benzylamine-4-carboxylic acid (new synthesis)[6] by Dr. A. Albert, University of Sydney, who are hereby thanked.

R. J. GOLDACRE.
Council of Scientific and Industrial Research,
Melbourne.

[1] Mitchell, G., Rees, W., and Robinson, C., *Lancet*, 627 (1944).
[2] Selbie, F., and McIntosh, J., *Brit. J. Exper. Path.*, **24**, 246 (1943).
[3] Schreuss, H., *Klin. Wochsch.*, **21**, 671 (1942).
[4] Albert, A., and Goldacre, R., *Nature*, **149**, 245 (1942).
[5] Bell, P., and Roblin, R., *J. Amer. Chem. Soc.*, **64**, 2905 (1942).
[6] Albert, A., and Magrath, D., *J. Chem. Soc.*, in the Press.

## Structure of Coronene

IN a recent communication[1], Robertson and White have reported provisional crystal structure determinations for coronene, $C_{24}H_{12}$. The molecule has great symmetry, as is shown by the figure. In view of the importance of this molecule in coal formation, some purely theoretical calculations I have made may be worth mentioning. Using the methods developed in an earlier paper[2], the energies of the mobile electrons have been computed in terms of the fundamental resonance integral β. From this it is easy to calculate the bond-orders and -lengths. The table below shows (i) the mean energy of the mobile electrons; (ii) the mean order of the C–C bonds; (iii) the order of the six central C–C bonds; (iv) the mean length of the C–C bonds; and (v) the length of the central bonds. Similar values are given for benzene and graphite. The last decimal place in the lengths is valid on a relative scale, but not on an absolute one. It may be added that the only experimental data used in this table are the lengths of the C–C, C=C and C≡C bonds in ethane, ethylene and acetylene.



Coronene, $C_{24}H_{12}$

PROPERTIES OF THE CORONENE MOLECULE.

| | Coronene | Graphite | Benzene |
|---|---|---|---|
| Mean energy per mobile electron | 1·440β | 1·576β | 1·333β |
| Mean order of C–C bonds | 1·576 | 1·525 | 1·667 |
| Order of central C–C bonds | 1·522 | 1·525 | 1·667 |
| Mean length of C–C bonds (A.) | 1·406 | 1·417 | 1·389 |
| Length of central bonds (A.) | 1·418 | 1·417 | 1·389 |

It is evident from the table that coronene lies between benzene and graphite, being nearer to the latter. The central bonds are very similar to the bonds of graphite, though the mean bond-length is about 0·01 A. shorter. This confirms the provisional conclusions of Robertson and White.

Further details will be published elsewhere.

C. A. COULSON.
University College,
Dundee. Nov. 15.

[1] *Nature*, **154**, 605 (1944).
[2] Coulson, C. A., *Proc. Roy. Soc.*, A, **169**, 413 (1939).

## Genetics of Woodlice

THE work of Howard and Vandel on the genetics of the terrestrial Isopoda are well known, and their erudite memoirs have opened up a new chapter in genetics. As illustrating the profound difficulties of the geneticist, the following facts are of interest. Unfortunately, I do not possess that knowledge of genetics to explain the following phenomena, but would gladly welcome some enlightenment.

Briefly the facts are as follows: I crossed a female specimen of *Armadillidium vulgare* Latr. var. *rufobrunneus* Cllge. with a male specimen of Howard's type *D*, with the ultimate result that I obtained a brood of 39 females and 7 males all referable to the type *D*. A female of this brood was crossed with the male parent and in due course I obtained a brood consisting of 28 females and 42 males, all referable to Howard's type *D*. A male and female of this brood were crossed, with the result that a brood was liberated consisting of 58 females all referable to the variety *rufobrunneus* Cllge., most of which died within two days of liberation from the brood pouch.

The above-mentioned facts may be briefly summarized as follows:

*Armadillidium vulgare*
♀ var. *rufobrunneus* × ♂ type *D*

Result 39 ♀ and 7 ♂ all type *D*
×
Result 28 ♀ and 42 ♂ all type *D*
×
Result 58 ♀ all var. *rufobrunneus*.

I should here like to express my best thanks to Dr. H. W. Howard and Dr. Hamilton E. Quick for their kindness in supplying me with material.

WALTER E. COLLINGE.
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## Heredity, Development and Infection

PROF. J. B. S. HALDANE's[1] letter on Dr. Darlington's[2] interesting and provocative article calls for two comments. First there is, I think, no published evidence to show that reversion from climber to bush type in roses is due to an agent transmitted from the stock (incidentally it may be noticed that Crane and Lawrence's[3] account of their experiment on p. 178 of their book does not mention the type of stock on which the buds were grafted). Even assuming that the difference between the climber and bush type is due to a change in a plasmagene, the reversion of a percentage of the buds might be due to the somatic sorting out of two different types of plasmagenes such as sometimes happens with plastids.

Secondly, at least a few British geneticists have been interested enough in the work of Lysenko and his colleagues in the U.S.S.R. for them to try experiments similar to those of the Russian workers. As no results have been published, one can only conclude they were negative. Thus I personally have experimented with the narrow-leafed rogue of peas[4,5] which Darlington[6] suggests is due to a plasmagene (seeds of type and rogue were kindly given to me by Miss C. Pellew for this work). Grafts of type on type, type on rogue, rogue on rogue and rogue on type were made in the seedling stages, and the length and breadth of stipules at flowering time measured. No effect of stock on scion was found.

H. W. HOWARD.
Plant Breeding Institute, School of Agriculture,
Cambridge. Oct. 17.

[1] *Nature*, **154**, 429 (1944).
[2] *Nature*, **154**, 164 (1944).
[3] "Genetics of Garden Plants", 2nd ed. (London, 1937).
[4] *J. Genet.*, **5**, 13 (1915).
[5] *Proc. Roy. Soc.*, B, **91**, 186 (1920).
[6] "The Evolution of Genetic Systems" (Cambridge, 1939).

## Inheritance of the Keel in *Potamopyrgus Jenkinsi* (Smith)

THE keel, when present in the aquatic and parthenogenetic mollusc, *Potamopyrgus Jenkinsi* (Smith), can exist in many degrees of strength. It may vary from the faintest of lines on the shell to a well-marked spinous keel, this latter being the aculeate variety of Overton.

Robson[1] found that colonies may be all smooth, all keeled, or the two forms may co-exist. The keeled forms may persist for years in the same locality, though the proportion keeled may vary from year to year, sometimes dwindling to zero. Boycott[2], who also worked on this character, found strongly keeled (aculeate) colonies rather rare. Juvenile keeled snails from the field, grown to adult size in the laboratory, were indistinguishable from wild-born adults. He also found many grades of development in the keel, and the occasional occurrence in Nature of the discontinuous development of the character when the keel fades off to give a smooth body whorl.

Both Robson and Boycott bred keeled snails in the laboratory. Robson, using keeled snails and fresh water of different chemical compositions and brackish water, obtained only perfectly smooth offspring. Boycott, using aculeate snails from a freshwater colony near Criccieth, obtained some keeled snails (mostly faintly keeled). However, conditions did not permit any definite conclusions to be drawn about possible causative conditions, except that keeled offspring more often appeared in the 'bad' conditions of open-air aquaria or in cultures kept in rusty tins. In recent years, similar experiments have been repeated, and in fresh water the few positive results have, like Boycott's, been inconclusive.

In 1943 a locality was found near Christchurch, Hants, where smooth snails live in a small freshwater stream and aculeate snails in the brackish water stretch of the same stream. These aculeate snails, bred in jars with brackish water of salinity 0·175 per cent and algal-covered pebbles from their native brackish stream (called keel-inducing conditions below), yielded 100 per cent aculeate offspring. Under similar conditions keeled and smooth snails, kept together in the same jar, yielded both keeled and smooth offspring. These experiments have been successfully repeated and amplified this year, and some of the main results are summarized, pending opportunities for carrying out more precise work.

A glass jar was immersed in the brackish stream at Christchurch for the second half of April 1944. This jar, filled with stream water and using keeled snails as parents, yielded both smooth and keeled offspring. A precisely similar experiment, using a jar immersed for part of May, gave only smooth *F*1. A jar set up with keel-inducing conditions and three snails—one perfectly smooth and the other two with barely perceptible keels—yielded an *F*1 of smooth snails and snails with a well-developed keel. Under similar conditions, ten smooth snails from a hundred per cent smooth colony yielded only smooth offspring. Experiments were also made by keeping snails, offspring of keeled parents, under keel-inducing conditions for varying periods of the first part of their lives and then transferring them to smooth-inducing conditions. A batch thus kept for the first 28–35 days of their lives before transference yielded seven individuals, only one of which was keeled. Similarly, of twelve snails kept 35–42 days before transference to smooth-inducing conditions (and

which were smooth at transference), eleven developed keels of varying strengths, one remaining smooth. The keel-inducing influence thus seems to act during the first few weeks of life. Snails first showed the keel at the age of about seven weeks. Though the discontinuous development of the keel has not yet been produced in the laboratory, its natural occurrence, on one occasion at least, seems to be due to accidental change of conditions from keel-inducing to smooth-inducing.

From the above experiments it appears that *P. Jenkinsi* exists as both keeled and smooth genotypes. Further, since brackish water *per se* does not induce a keel, it seems that the environmental factor responsible for the appearance of the keel is Algal. Moreover, this agency needs only to act in early life to induce a keel for the rest of the life of the snail. The Alga probably acts partly in a quantitative manner to produce keels of strengths varying from a scarcely perceptible ridge to the fully aculeate form.

As already stated, the offspring obtained from jars immersed during April and May at Christchurch were a mixture of keeled and smooth and smooth respectively. These results may throw some light on the many negative results previously obtained in experiments on the inheritance of the keel. It appears likely that, especially in freshwater, the keel-inducing species of Alga may have a relatively short life under the laboratory conditions tried hitherto. Jars with a healthy growth of brackish water Algæ from Christchurch on pebbles yielded 100 per cent keeled offspring from keeled parents. In the above two jars, however, the Algæ only remained healthy for a short time, later forming a flocculent precipitate. The keeled snails in the April jar were older (larger) than the smooth snails. This may be significant as suggesting that the older snails were in the labile condition for keel production at a time when the keel-inducing Alga was still alive in sufficient quantity in the culture. It is to be expected that some smooth colonies will prove on breeding analysis to contain a proportion of genotypically keeled specimens.

I am indebted to Miss C. H. Popham, of Christchurch, for helping in the collection of field material and to Mr. Moffatt, of Hambleden, for facilities in housing experiments.

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[1] Robson, G. C., *Brit. J. Exp. Biol.*, **3**, 149 (1926).
[2] Boycott, A. E., *Proc. Mal. Soc.*, **18**, 230 (1929).

## A Method of Obtaining Tissue Cultures of Adult Fibroblasts

IN recent years we have made several attempts to infect tissue cultures of fibroblasts from chicks and fowls of various ages with the virus of Rous sarcoma No. 1. Although we were not satisfied that such infection can take place *in vitro*, we gained some experience in methods of obtaining tissue cultures of adult fibroblasts, which may be of interest to others.

Resting adult connective tissues did not give satisfactory cultures, and it was necessary to devise a method of setting up local connective tissue proliferation, and afterwards removing cells at various intervals of time. Methods involving open operations were avoided, because of the risk of airborne bacterial contamination. In our first experiments, we implanted various kinds of threads into the breast muscles of fowls and withdrew them after different time-intervals, together with proliferating cells that had become entangled in them. This method, though satisfactory up to a point, had the disadvantage of introducing foreign matter into the culture medium and was sometimes accompanied by infection. The most satisfactory method was as follows. Small glass capillary tubes, 1·5 cm. long and 2·0 mm. outside diameter, were implanted into the breast muscle of fowls by means of a trocar and canula. The tubes were open at both ends, but a constriction at one end allowed a knotted thread to be retained by the tube and served to withdraw it at the desired time. A small skin incision can be made before inserting the trocar and canula to reduce the risk of introducing organisms from the skin; but this was not found to be necessary if the skin was well prepared with 1 : 1,000 acriflavin in 50 per cent methylated spirit immediately before operation. After introducing the tubes through the canula, the latter can be withdrawn, leaving the free ends of the threads protruding from the wound. These can conveniently be tied together and anchored to the skin with a stitch which also closes the wound.

Such small tubes, when withdrawn after intervals of one to ten days, are found to contain fibrin clot invaded by fibroblasts and macrophages; they are, in fact, miniature tissue cultures. By breaking the thin capillary tube, the contents can easily be liberated for implantation into suitable culture medium in roller tubes or other type of tissue culture apparatus. The method has the advantage of simplicity, and reduces handling with consequent risks of infection by airborne organisms. Cultures obtained in this way were maintained for about two weeks on fowl plasma desiccated embryo extract medium without the addition of any living cells.

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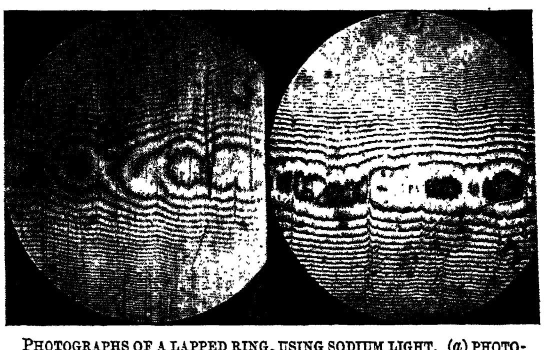
## Silvered Mirrors for Interferometric Measurement

THE simple interferometric devices used in Great Britain[1] and on the Continent for testing the surface quality of workpieces of less than 20 micro-in. surface roughness have recently been improved by applying a partly reflecting mirror as suggested by L. Leinert[2]. This method has been compared with



PHOTOGRAPHS OF A LAPPED RING, USING SODIUM LIGHT. (*a*) PHOTOGRAPHED THROUGH AN ORDINARY GLASS COVER SLIT; (*b*) PHOTOGRAPHED THROUGH SILVER SPUTTERED MIRROR. MIRROR BY COURTESY OF MESSRS. C. J. WHILEMS, LTD., ILFORD OPTICAL WORKS, FORREST ROAD, BARKINGSIDE, ESSEX.

the usual practice of using non-silvered glass[1] and the results are quite interesting. Whereas with non-silvered glass the interference bands are relatively weak and the underlying surface with its imperfections is easy to recognize, the silvered glass of the same surface shows the outlines of the interference bands very clearly (see accompanying reproductions). This is due to the fact that in this case the scattered light from the workpiece cannot penetrate the silver layer. A much better topographic picture of the surface is thus obtained; but it is open to question whether for practical inspection purposes a combined picture of surface and interferences would not be more desirable.

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[1] Kayser, J. F., *Industrial Diamond Review*, 4, 2 and 72 (1944).
[2] Leinert, L., *Werkstattstechnik Der Betrieb*, **37/22**, 279 (July, 1943), extracted in *Eng'neers Digest*, 5, 247 (August, 1944).

## Significant Figures of Numbers in Statistical Tables

IT is a well-known fact that most numbers in statistical tables start with a small digit. For example, in population tables almost one third of the entries begin with the digit 1. The same holds true for most tables of the type occurring in the World's Almanac.

A rough qualitative explanation of this fact can easily be given. If we consider tables in which the entries become rarer the larger they are, we can draw the obvious conclusion that in any interval, say, between 10 and 99, or 10,000 and 99,999, there are more entries on the small side than on the large side.

The quantitative aspect of this phenomenon requires a more detailed discussion. The study of a large number of tables shows that of all entries the fraction which begins with the digit 1 is given by $\log_{10} 2/1 = 0{\cdot}301$, beginning with 2 it is $\log_{10} 3/2 = 0{\cdot}176$, and, in general, the fraction with $p$ as its first digit is $\log_{10}(p+1)/p$. This quantitative behaviour has been studied in detail by Benford[1]. In spite of his investigation, Benford appears to arrive at the conclusion that this logarithmic distribution of the first digits is some natural phenomenon which he calls the "Law of Anomalous Numbers". In reality there is nothing profound about this 'law' and it is certainly not connected with the observation that "Nature counts $e^0$, $e^x$, $e^{2x}$, . . . and builds and functions accordingly". It is merely the result of our way of writing numbers, as we shall demonstrate below.

Consider an arbitrary table with a large number of entries which either are all positive or else are considered without regard to sign. Let $f(x)dx$ be the fraction of entries in the interval between $x$ and $x + dx$; then

$$\int_0^\infty f(x)dx = 1. \quad . \quad . \quad . \quad . \quad . \quad (1)$$

If the basis of our number system is $A$, for example $A = 10$, we shall write each entry $x$ of the table in the form

$$x = pA^m, \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where we take

$1 \leq p < A$; $m$=integer: positive, negative or zero. (3)

In this way $p$ is a continuous variable which can be used to indicate the first digit of the number $x$; for example, if $p$ is between 3 and 4, the first digit of $x$ is a 3. More generally, $p$ gives the significant figures, $m$ the order of magnitude. We want to know what fraction of the entries has the value of $p$ lying in a small interval between $p$ and $p + dp$. For a fixed value of the exponent $m$ this is given by

$$f(x)dx = f(pA^m)\, A^m dp. \quad . \quad . \quad . \quad . \quad (4)$$

We must next sum this over all values of $m$, and the required fraction becomes

$$F(p)dp = \sum_{m=-\infty}^{m=+\infty} f(pA^m)A^m dp \quad . \quad . \quad . \quad (5)$$

This equation represents the mathematical formulation of the process of 'counting the first digits' of the entries in the table. If we integrate Equation (5) over $p$, between 3 and 4 say, we get the fraction of entries starting with the digit 3.

We next estimate the sum in Equation (5) by approximating it by an integral

$$F(p) = \sum_m f(pA^m)A^m \cong \int_{-\infty}^{+\infty} f(pA^m)A^m dm. \quad . \quad (6)$$

This integral is easily evaluated, for by substituting again the expression for $x$,

$$x = pA^m,\ dx = pA^m \ln A\ dm, \quad . \quad . \quad . \quad (7)$$

we find using Equation (1):

$$F(p) \cong \int_0^\infty f(x)dx/p \ln A = 1/p \ln A \quad . \quad . \quad . \quad (8)$$

The fraction of entries which have $p$ in an interval from $a$ to $b$ is

$$\int_a^b F(p)dp = (\ln b - \ln a)/\ln A = \log_A \frac{b}{a} \quad . \quad (9)$$

By taking $A = 10$ and $a$ and $b$ two consecutive integers, we have the required distribution law. The main point in this derivation is that the integral in Equations (6) and (8) is independent of the function $f(x)$, that is, independent of the distribution of the magnitudes of the entries in the table. The logarithmic distribution of the first digits has nothing to do with the nature of the entries in the table or with their distribution.

One important question has still to be considered, namely, how accurately the integral in Equation (6) approximates the sum. The answer to this question does depend upon the properties of $f(x)$. It is thus easy to find examples of tables for which the logarithmic distribution of the first digits is not true, by choosing $f(x)$ in such a manner that the sum differs widely from the integral; this is so, for example, for a table of populations of places with five thousand or more people, in which almost as many entries occur with first digit 5 as with first digit 1. Moreover, the range of most tables is not very large, and therefore the sum over $m$ for any one table contains only a few terms. The observed agreement is probably improved by the fact that we integrate between two integers $p$ and $p + 1$, which presumably has a smoothing out effect.

$A = 10$

| First digit | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|
| Actual | 636 | 341 | 256 | 211 | 168 | 154 | 130 | 111 | 102 |
| Expected | 635 | 371 | 263 | 205 | 167 | 141 | 122 | 108 | 97 |

$A = 100$

| Number of digits | odd | | | even | | |
|---|---|---|---|---|---|---|
| First digits | 1 | 2, 3 | 4–9 | 1 | 2, 3 | 4–9 |
| Actual | 359 | 309 | 396 | 277 | 288 | 480 |
| Expected | 317 | 317 | 420 | 317 | 317 | 420 |

Some of the questions connected with the approximation of the sum by the integral are discussed in another communication by Furry and Hurwitz[2]. It is

obvious that the approximation will be good for sufficiently small $A$ and poorer for larger $A$. This is illustrated by counts of a group of population tables using first $A = 10$ and then $A = 100$, as shown in the tables. The expected numbers are calculated from Equation (9). In this case $A = 10$ is small enough for the agreement to be good ($P(>\chi^2) \simeq 0 \cdot 77$ on Pearson's test of goodness of fit), but $A = 100$ is not ($P(>\chi^2) \simeq 0 \cdot 0003$).

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Aug. 30.

[1] Benford, Frank, *Proc. Amer. Phil. Soc.*, 78, 551 (1938).
[2] *Nature*, in the press.

## Observations on Bird Behaviour

DR. K. G. BRITTON has recently described the behaviour of "a deluded sparrow"[1]. I can quote an almost identical case which happened some years ago. Early one summer morning I was awakened by a cock house-sparrow pecking violently at my bedroom window, which faced nearly due east. This was repeated the next morning. Between onslaughts at the window glass the sparrow clung to ivy which covered the deeply recessed sides of the window. This continued for a week, after which time the sparrow disappeared.

Dr. Britton draws interesting implications from the experiments and observations he made, namely, (*a*) mental maladjustment of the sparrow, (*b*) the possibility of intelligence well above the instinctive level. I should like to add collaborative examples of both postulates.

(*a*) *Mental maladjustment*. A hen blackbird nested in our garden and successfully reared two young ones. When these no longer required feeding, she continued for two or three weeks to offer food to any bird, adult or fledgling, that came near her. A young thrush accepted food, and once, when the blackbird offered a worm to an adult robin, it accepted this, whether from surprise or intention one cannot tell.

(*b*) *Intelligence*. The parents of a family of fledgling house-sparrows brought their young to feed on a supply of crumbs which we placed regularly on our verandah. When the parents ceased their care of the young sparrows, the latter continued to come by themselves. It was soon possible for us to recognize two individuals among them. One held its head on one side and the foot and leg of the other side were partly paralysed. The bird was timid, stupid and at a disadvantage. The second was a hen bird: in time we learnt to recognize her by slight individualities of proportion and colouring; but before this her behaviour distinguished her clearly. She took charge of the cripple, led it to food, and encouraged it by chirp and by suitable feeding movements. One day, as we sat very still in the lounge, with the door leading on to the verandah open, the young hen led her 'afflicted brother' through the door and across the floor to crumbs fallen under the table. She watched him feed and escorted him back to safety again.

It is usually stated that all bird behaviour is instinctive. Much of it can, of course, be adequately described by this term. It seems inadequate, however, to speak as though the whole of animal behaviour, vehicled through such diverse types of nervous systems, can be classified under one of two terms—instinct or intelligence. Such stultified and obsolete terminology has long since been advanced upon by the psychologist dealing with human behaviour. Human psychology has developed terms for all the grades of specific psychic* phenomena. In our opinion biologists are hampered by this paucity of psychological terms, a condition which tends to mask instead of to clarify the ideas at issue. No doubt fuller terminology has been developed by specialist workers, but nothing of the kind is used by biology or natural history at large.

E. M. STEPHENSON.
CHAS. STEWART.
(lately of) University College of the South West,
Exeter. Oct. 12.

* Using the word in its legitimate sense.
[1] *Nature*, 153, 559 (1944).

WITH regard to the cock house-sparrow reported in *Nature* of May 6, 1944, as continually attacking its own reflexion in a glass window, a peacock of mine was a great nuisance because he would fight himself, in windows and the bright parts of cars. I have seen a cock house-sparrow attacking a window, and cases have been reported to me of a male blackbird, chaffinch, robin, dipper (at a house near a stream) and a grey wagtail doing the same. In all these cases the bird appeared to mistake its reflexion for a rival male trespassing on its territory and strove long and steadfastly to expel the intruder.

FRANCES PITT.
The Albynes, Bridgnorth. Dec. 3.

## Wharton's Jelly Considered as a Conducting Path

IN connexion with the interesting discovery by Barcroft *et al.*[1] of the passage of molecules as large as serum albumin along the Wharton's jelly of the umbilical cord of the sheep, I beg to offer the following comments.

So far as the supply of nutriment (other than water) to the fœtus is concerned, in the late stage of development of the experimental specimens employed, namely, after the establishment of a fœtal vascular system and of its relation to the maternal endometrium, the transmission of large-sized molecules at a relatively slow rate along the Wharton's jelly may be considered to be only a minor method of nutritive supply compared with the rapid transmission of substances with smaller molecules by the blood stream. But the discovery of this function of the Wharton's jelly becomes of paramount importance, if we may postulate that, in the very early stages of development before angiogenesis has commenced, the primitive mesoblast, from which the Wharton's jelly is derived, has the same power to transfer large-molecule substances from the trophoblast (and hence from the endometrium) to the embryo. In this light, the early development of the primitive mesoblast in the monkey[2], and its even more precocious development in man[3,4], becomes of considerable significance.

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Nov. 30.

[1] Barcroft, J., *et al.*, *Nature*, 154, 667 (1944).
[2] Heuser, C. H., and Streeter, G. L., *Contrib. Embryol. Carneg. Inst. Wash.*, 29, No. 180, 15 (1941).
[3] Davies, F., *Trans. Roy. Soc. Edin.*, 61, pt. II, 315 (1944).
[4] Davies, F., and Harding, H. E., *J. Obstet. Gynæcol. Brit. Emp.*, 51, 225 (1944).

## St. Jerome and Vitamin A

THE following passage, taken from St. Jerome's "Life of St. Hilarion", which was written about A.D. 392, appears to be the earliest account of the etiology, symptoms and cure of severe vitamin A deficiency. "From his thirty-first to his thirty-fifth year he had for food six ounces of barley bread, and vegetables slightly cooked without oil. But finding that his eyes were growing dim, and that his whole body was shrivelled with an eruption and a sort of stony roughness (*impetigine et pumicea quadam scabredine*) he added oil to his former food, and up to the sixty-third year of his life followed this temperate course, tasting neither fruit nor pulse, nor anything whatsoever besides."

This combination of an eye-affection, night-blindness or perhaps xerophthalmia, with a severe hyperkeratosis precisely resembles the condition described by Frazier and Hu[1] as occurring in Chinese patients who had received a diet not unlike that of St. Hilarion, namely, a cereal other than wheat, white cabbage and salted vegetables. These patients were speedily cured by cod-liver oil or carotene; and it seems probable that a crude and unpurified olive oil, such as St. Hilarion would have permitted himself, would contain enough of the fairly high vitamin A content of the olive to relieve his symptoms and maintain good health. The evident accuracy of St. Jerome in this particular may induce further study of this interesting biography.

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[1] Frazier, C. N., and Hu, C. K., *Arch. Dermat. and Syph.*, **33**, 825 (1936).

## West Cumberland and its Utilization

As one who has had contacts, through geology, with industry, mining and agriculture in Cumberland during a quarter of a century, may I be permitted to comment upon Dr. Stamp's article on "West Cumberland and its Utilization" in *Nature* of November 18.

The basic causes of the depression in West Cumberland during the 'thirties are only too fully recognized, and lack of transport facilities cannot be regarded as one of them. Indeed, as the raw materials for the iron and steel industry are found within the district, the transport from mine to furnace and furnace to factory is almost eliminated.

Although West Cumberland does not lie on the western main route from England to Scotland, it is misleading to describe it as lying at the end of a branch line from Carlisle. It is connected with the main railway route at three places, Carlisle, Penrith and Carnforth. Admittedly the south route needs improving. The urgent need here is for a railway and road, across the Duddon Estuary, so quartering the road and rail distance between Askam and Millom.

The intense depression in the heavy iron and steel industries in the 'thirties was national, but in West Cumberland its effects were felt not only in the rolling mills, the blast furnaces and the coke ovens, but also in the local iron-ore mines, limestone quarries and coal mines, which supplied the raw materials for the heavy industries. The presence of coal, hæmatite and limestone in the same area are natural advantages enjoyed by West Cumberland, and to them we may add two more. Adequate water supplies are, or can be made, readily available. The district is served by ports, so that foreign hæmatite, when needed, comes into the district by the cheapest means of transport—transport by sea—and exports flow from the ports.

These natural advantages are beneficial during times of trade prosperity; but because the industries are so largely interrelated and interdependent, the whole district is especially susceptible to trade depressions. The need for new industries is self-evident.

Dr. Stamp's statement that under certain contingencies "the enormously important influx of wealth from holiday makers will cease" is difficult to understand. Alas, no such wealth has ever flowed into West Cumberland. West Cumberland should not be confused with the Lake District, from which it is quite distinct, both topographically and geologically. The present industrialization of the former district in no way affects the amenities of the latter, and the position would not be changed by bringing new industries into West Cumberland.

Whether the Lake District becomes a national park or not, the holiday resorts for this lovely district will continue to be largely centred on Keswick, Ambleside and Penrith, all far removed from the industrial West Cumberland. As regards the seaside villages on the West Cumbrian coast, these are primarily the holiday resorts of local people. Their prosperity will reflect the prosperity of the industrial area.

Everybody will agree that regional "planning is essentially the right allocation of land". In Cumberland the allocation would appear to be: land for industries in the industrial zone of West Cumberland, the minimum inroad by industry into the rich agricultural land surrounding Carlisle, and the reservation of the Lake District as a national park.

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I HAVE no quarrel with most that Dr. Trotter says, but his letter strikes just that note of false optimism which it was my concern to avoid. Apart from the steady deflexion of the hæmatite reserves, the heavy iron and steel industry is naturally well sited, but to say the "need for new industries is self-evident" is a long way from suggesting how they can be attracted. It is in this regard that a manufacturer seeking a location for, say, a textile factory, would look seriously at the time taken to reach an area off the main line by which his goods would be distributed. It is 1½ hours by rail to Whitehaven from Carlisle, 2¼–3 hours from Penrith and 2¾–3¾ hours from Carnforth. I was not, of course, confusing West Cumberland with the Lake District; but it is important to realize that the war-time extension of the industrial area has introduced an alien element in the once purely rural views from the high ground of the western Lakes. To say that the charming West Cumbrian coast from St. Bee's Head to Millom is primarily the resort of local people is to deny its immense potentialities as a natural seaside extension to the Lakes, which increased facilities of access and accommodation should render very popular and a consequent source of wealth to the area—but not if it is spoiled by sporadic industrialization.

L. D. STAMP.

# RAT PLAGUES IN WESTERN QUEENSLAND

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PLAGUES of native species of rodent recur from time to time in the dry inland plains of Australia[1,2,3,4]. Palmer[3] describes an outbreak of rats (apparently the long-haired rat, *Rattus villosissimus* Waite[4]) which occurred after continuous rains during 1869–70, and moved northwards across the Gulf Country plains from the head of the Flinders River (Fig. 1). There was a corresponding increase in native dogs, snakes, hawks and owls which, together with the exhaustion of the food supply, the drying of the grass at the end of the season and their own cannibalism, brought the plague to an end. Evidence of previous plagues was found in "hollow trees, in which owls had lived for years, [which] were filled with the bones and skulls of millions of rats". Troughton[4] (p. 286) observed another outbreak of *R. villosissimus* on the Barkly Tableland in 1934. I have been unable to obtain records of plagues on the plains of Central Western Queensland further back than the beginning of this century; but since then *R. villosissimus* has erupted here at intervals of approximately eleven years, in 1907, 1918, 1930–31 and 1940–42. Each time the rats travelled in a roughly south-easterly direction. During April–June 1907 they moved at night on a 150-mile front south and south-east from the Flinders River, and were followed by large numbers of wild domestic cats and dingoes[1]. In this year, and in 1918, it was observed that practically all those trapped were males[1].

Several correspondents have kindly described to me the latest plague of *R. villosissimus* (identified by the Queensland Museum), which has recently subsided. Migration was not continuous. The rats took about two years to go from Boulia to the Thompson River at Longreach, a distance of about 200 miles. They were present in large numbers at Quilpie in March 1941. At a point $X$ (Fig. 1), the course of the plague was as follows. They had arrived at a place 60 miles north-west of $X$ about two months before they reached $X$ itself in fair numbers in December 1940. In January 1941, their numbers greatly increased and persisted at this level until about October of the same year. It is difficult to estimate the actual population density. Between 3 and 53 were caught per night in traps consisting of a tip-board which dropped the vermin into a large tub of water, a number of which were set round the verandahs of the house. The population decreased suddenly in December 1941, rose again in February 1942, and fell once more in April. The rats finally disappeared after the heavy, soaking rains of May 26, 1942, and very few were seen after that. They fed mainly on vegetable matter, destroying all the fruit and vegetables in gardens except, according to one correspondent, parsnips and members of the onion family. They would also eat meat, leather, etc., when they found it. Cannibalism was widespread. An observer at Boulia "was informed from reliable sources that 95% of the rats trapped were males". In plagues of *Mus musculus*[1] there was a preponderance of females before, and of males after, they began to migrate. The reason for the preponderance of males was apparently that they led the migrations and left no food behind them for females and young, which then resorted to cannibalism. All the above observations on *R. villosissimus* were made on migrating swarms.

All four rat plagues were followed by plagues of feral cats, which later died of disease and starvation. In 1931, the rats reached their maximum at $X$ in May, and the cats were dying in large numbers by September. On one occasion 73 cats were shot in a day about the house and garden at $X$. The number

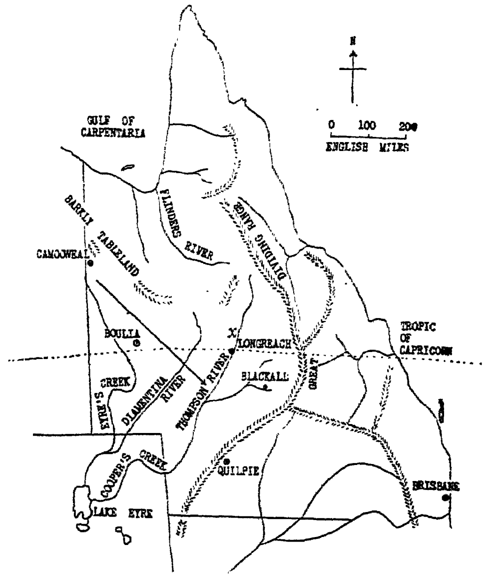


FIG. 1. MAP OF QUEENSLAND. THE ARROW SHOWS THE GENERAL DIRECTION OF THE PLAGUE OF *Rattus villosissimus* IN 1940–42.

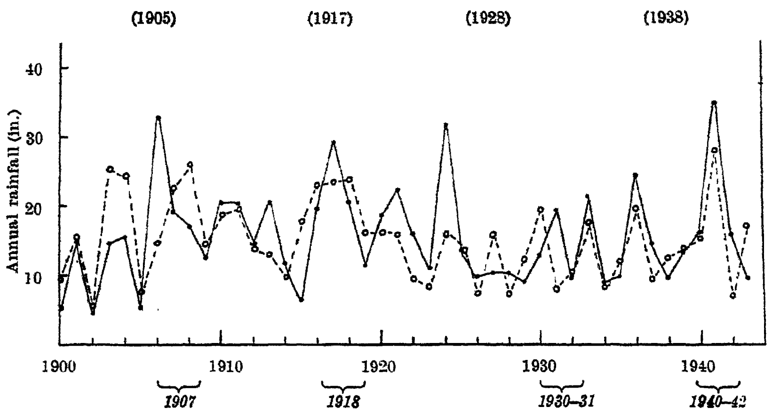


FIG. 2. ANNUAL RAINFALL AT LONGREACH (●) AND CAMOOWEAL (○) FROM 1900–43. IN GENERAL THE ANNUAL RAINFALL OF THE WHOLE OF WESTERN QUEENSLAND FOLLOWS THE SAME COURSE, BUT DECREASES FROM NORTH-EAST TO SOUTH-WEST. PLAGUE YEARS ARE SHOWN IN ITALICS. YEARS IN WHICH SUNSPOT MAXIMA OCCURRED ARE GIVEN IN BRACKETS ABOVE THE CHART.

of foxes increased enormously in 1941 and remained high until October 1942, when they began to die of canine distemper. The number of cats also rose rapidly at the beginning of 1942, but at the end of that year feline distemper caused a dramatic fall in population. Large numbers of cats were found dead or dying about the countryside during August and September. Ringworm was common in the cats in 1942 and was transmitted to station dogs and occasionally to children. These diseases would spread rapidly in such dense populations[5]. After the outbreaks were ended, rats, cats and foxes continued to exist at their normal low level of population.

There are in general three prevailing views about the cause of fluctuations in population[6,7]. (1) They may be attributed to climatic changes, such as when exceptionally favourable conditions allow a species to take advantage of its potentially rapid rate of reproduction[8,9,10,11]. (2) The inherent instability of populations of several ecologically related species may produce oscillations quite apart from environmental changes[12,13,14,15,16,17]. (3) Outbreaks may be due to unnatural conditions created by the activities of man. Fig. 2 shows that three of the four plagues described above were associated with exceptionally rainy seasons[18]. On the other hand, the plague years 1930–31 were not especially wet, while other wet years did not have plagues. It is possible that in 1930–31 temperature or other conditions may have favoured increase. MacLagan[19] has shown that over the last hundred years the frequency of outbreaks of several British insects is correlated with the periodicity of sunspots. The connecting link between sunspots and outbreaks is climatic. Each of the four plagues described above began within two years of the sunspot maximum immediately preceding it. It is possible that there may be some connexion between them; but the number of records is too few to establish either this or the contrary.

I wish to thank Mr. G. W. Moule, Government veterinary surgeon, Central West, for his kindness in sending some of the information quoted above; Mr. H. A. Longman, director of the Queensland Museum, for other information; and Mr. J. H. Pike, Agent-General for Queensland, for the loan of "Tables of Rainfalls in Queensland" (1933). My other correspondents will be nameless, but not unthanked.

[1] Le Souef, A. S., Burrell, H., and Troughton, E. le G., "The Wild Animals of Australia", 105 (London: Harrap, 1926).
[2] Longman, H. A., *Mem. Queensland Mus.*, **5**, 23 (1916).
[3] Palmer, E., *Proc. Roy. Soc. Queens.*, **2**, 193 (1885).
[4] Troughton, E. le G., "Furred Animals of Australia", 271, 286 (Sydney: Angus and Robertson, 1941).
[5] Topley, W. W. C., *Lancet*, 477, 531 and 645 (1936).
[6] Elton, C., "Voles, Mice and Lemmings" (Oxford, 1942).
[7] Clements, F. E. and Shelford, V. E., "Bio-Ecology" (New York: Wiley, 1939).
[8] Elton, C., *Brit. J. Exp. Biol.*, **2**, 119 (1924).
[9] Elton, C., "Animal Ecology" (London: Sidgwick and Jackson, 1927).
[10] Elton, C., and Nicholson, M., *J. Anim. Ecol.*, **11**, 96 (1942).
[11] Huntington, E., *Science*, **74**, 229 (1931).
[12] Cutler, D. W., Crump, L. M., and Sandon, H., *Phil. Trans. Roy. Soc.*, B, **211**, 317 (1922).
[13] Gause, G. F. "La théorie mathématique de la lutte pour vie" (Act. Sci. et Indr. No. 277. Paris: Herman, 1935).
[14] Huntsman, A. G., *J. Fish. Res. Board Can.*, **5**, 227 (1941).
[15] Severtzoff, S. A., *Quart. Rev. Biol.*, **9**, 409 (1934).
[16] Smith, H. S., *Ecol. Monogr.*, **9**, 311 (1929).
[17] Volterra, V., and D'Ancona, U., "Les Associations biologiques au point de vue mathématique" (Act. Sci. et Indr. No. 243. Paris: Herman, 1935).
[18] Jones, I., "Tables of Rainfalls in Queensland", Meteorological Bureau, Brisbane (1933).
[19] MacLagan, D. S., *Proc. Univ. Durham Phil. Soc.*, **10**, 173 (1941).

# TROPICAL PASTURES

THE best grassland has depended for its existence upon a moderately cool and humid climate. Only a relative few of those familiar with the almost perpetual verdancy of English meadows and pastures realize the intensity of longing expressed in Psalm xxiii for *green* pastures and running waters seldom seen in a semi-arid land. In the tropics a high rainfall promotes the formation of acid soils, and a high temperature makes it difficult for most turfy grasses to form what inhabitants of temperate climates regard as a sward. Choice of tropical fodder plants is so limited that some varieties of sugar-cane are impressed into the class of forage grasses; and most of the tropical grasses are either tall and erect, or trail to make a tangled cover, neither type of growth being so amenable as that of the grasslands of Great Britain or of the temperate lands colonized by European pasture-species.

The difficulties of establishing a pasture in the tropics are added to by an apparent lack of suitable leguminous companion plants: no legume having properties corresponding to wild white or subterranean clover has been found.

Two recent Bulletins (Nos. 31 and 32) of the Imperial Bureau of Pastures and Forage Crops at Aberystwyth deal with pasture problems. No. 31 is entirely, and No. 32 partly, devoted to problems of management in the warmer countries. No. 32 ("Advances in Grassland Husbandry and Fodder Production: a Symposium") is a miscellany, ranging from an appreciation (with bibliography) of the scientific work of R. D. Williams to a review of field experiments at Potchefstroom and a note on the fixed oil of the seeds of *Trifolium subterraneum*. The articles are mainly reviews or abstracts, the 'symposium' thus being a gathering of varied information which might not otherwise have been published, or, if published, might escape the attention which the compilers seem to think it deserves. There is no common thread of interest.

Under the title "The Provision of Animal Fodder in Tropical and Subtropical Countries: Part One", Bulletin No. 31 gives a succinct account of experience and hopes in the West Indies, Hawaii, Fiji, the Gold Coast, Nigeria, the Anglo-Egyptian Sudan, Zanzibar and Pemba, and Southern Rhodesia. The information it gives will be valuable not only from the purely grassland aspect but also from sociological points of view, since for example in West Africa the potentialities of change in the type of husbandry are of high social importance. That is also true of the West Indies, and indeed the paper written by D. D. Paterson with assistance from other West Indian authorities is a masterly presentation in brief of the whole problem implied by an extensive establishment of good grassland in the tropics.

To find species that would grow at all under the given conditions has been the first thing, and with limited experimental resources it has been natural to neglect matters like those which have not received full attention in more highly developed areas.

Quality of herbage, and its effect upon livestock, is largely an open question in the tropics, few chemical analyses being available. Paterson remarks: "There can be no doubt that under tropical conditions the chances that the herbage may be lacking in some essential minor constituents are not less than in temperate countries. . . . After a spell in some of the other islands, racehorses reared in Tobago do not

stand up to the strain of the racecourse as well as they do in their home island". Pressure of research in other directions is given as the reason for deferment of intensive study of the role of minor elements; but it seems fair to ask why the question of nutritional quality should be taken so fatalistically. The salary of a chemist or two would surely not be too much to add to an ordinary budget of chemical or veterinary investigation, and in conjunction with a rational policy of land use and nutrition would probably yield a high dividend.

The bulletin contains a large number of suggestive facts. Fiji has no native grass, the so-called 'native' grasses being importations which have run wild. In view of the decline of the natural indigo industry, it is interesting to learn that the cultivation of a trailing species of indigo for fodder and for purposes of soil protection is actually on the increase. What is a pest in one part of the world may be a useful grass in other parts of the world—or, as in Hawaii, in another part of one island. HUGH NICOL.

## ECOLOGICAL PRINCIPLES AND FORESTRY

ON July 2, 1943, members of the forestry associations of Great Britain met at the invitation of the British Ecological Society to discuss problems arising from a paper by Sir Roy Robinson in *Forestry*, the journal of the Society of Foresters of Great Britain (see *Nature*, 152, 196; 1943). A fuller account of the meeting is now available (*Forestry*, 17; 1943).

Prof. A. G. Tansley, in opening the meeting, said he welcomed the desire for a closer contact between ecology and forestry. He thinks foresters would, through ecology, find much to help them to a scientific rationale of their practical operations. Prof. Tansley stresses that scientific ecology is a very young subject of research, almost entirely a product of the present century and only developed energetically since the War of 1914–18. It is in this newness of the subject that may lie the danger for the young forester. As is said, it has only been really developed since the War of 1914–18, and it is in this period that the word 'ecology' has come trippingly from the lips and pens of the young trained forester, the word being often made to serve as explanation for forestry processes as yet but dimly understood or assimilated by the junior. Prof. Tansley says: "I know very little of practical forestry, and I have often wished when I was teaching forestry students their elementary botany, and always from the general point of view of ecology, that I had had a practical training both in forestry and agriculture, just as I wished I had had a practical training in medicine when I was teaching biology to medical students. For just as scientific medicine is really a branch of applied biology, so forestry and agriculture may be regarded as branches of applied ecology."

To increase our knowledge of the ecology of woodlands, Prof. Tansley suggests a "continuous opportunity for access to and study of planting experiments together with the power of suggesting different variations and forms of control which are likely to lead to increased insight into the factors at work"—in fact, research work, which all foresters would welcome. It is, however, at present, a long step from this interesting and valuable work to the ordinary practical operations of the forester based on the growth of crops to produce marketable timber. Sir Roy Robinson's explanation that in afforestation work some species are pioneers and others are successors is obviously correct. But practical research is required to show how to shorten the experimental period in new afforestation work, if such a step is economically or ecologically possible from the financial point of view.

The experienced practical forester feels that a distinction should be sharply drawn between the true ecological research point of view and its work, and the practical sylvicultural activities of the executive forester who has to acquire a working knowledge of his soils in order to undertake his duties. In other words, the danger nowadays for the younger generations of foresters is that they may be led into sylvicultural inaction pending the outcome of the ecologists' experiments, giving the latter "the power to suggest different variations and forms of control" of the sylvicultural operations of the forester. The highly efficient sylvicultural management gradually brought into being in European Continental forestry departments was not attained by such means, though such research work will always prove of value to the sylviculturist when it has been brought to the point where its practical applications will obviously lead to better results.

## BIOLOGICAL STUDIES IN SOUTH AFRICA

THE *South African Journal of Medical Sciences*, published quarterly by the University of Witwatersrand and the South African Institute for Medical Research, is devoted to original work in any of the sciences represented in the medical curriculum. C. de V. Bevan contributes to the February 1944 issue (9, No. 1) an interesting article on the cultivation of the South African Rickettsiæ in developing chicks and the preparation of vaccines from the membranes of these. Dilute egg vaccines do not, he concludes, protect guinea pigs against epidemic infection, although they protect wholly against tick-borne infection and partially against endemic infection. Concentrated vaccines must be used in order to obtain complete protection against epidemic typhus produced by inoculation of guinea pigs with egg-passaged strains. A modified Machiavello technique for staining Rickettsiæ is described. The author finds that clearer staining is obtained if the smears are cleared in benzene. Bacteria and Rickettsiæ ground in a mortar with alundum are disintegrated. The development of the chick-embryo method will provide, the author thinks, smaller quantities of a far more potent vaccine than any that has yet been produced. The advantages of the egg-vaccine over the mammalian vaccines are discussed.

In the same issue, Margaret L. Creed discusses the nutritional value of a poor South African diet and of certain dietary supplements, and N. Sapeika reports on the digitalis action of a glycoside from the liliacean species *Urginea rubella*. More than twenty-five species of *Urginea* have been recorded in South Africa; many of these probably contain a toxic glycoside and a few are known to be toxic to stock. The issue concludes with a paper by O. S. Heyns and S. S. Hersch on the birth-weight of urban Bantu and the incidence among them of syphilis, still-birth and premature labour.

The Biological Supplement to this journal is published separately. The February 1944 issue includes a noteworthy article by C. J. van der Horst on further stages in the embryological development of *Elephantulus*, the affinities of which with the Insectivora and Lemuroidea relate this study to the embryology of the primates and of man.

Christine Gilbert records work on the development of the post-renal segment of the inferior vena cava in the same species. G. H. Roux gives a beautifully illustrated account of the cranial anatomy of the marine amphibian *Microhyla Carolinensis*. Protozoology is represented by a description, by A. J. Gibbs, of the life-history of the Adeleid coccidian *Chagasella* sp., found in the salivary glands of the plant-feeding Hemipteran *Cenœus carnifex*.

G. LAPAGE.

## FORTHCOMING EVENTS

### Thursday, December 28

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Harold Spencer Jones, F.R.S.: "Astronomy in our Daily Life", 1: "The Spinning Earth" (Christmas Lectures).

### Saturday, December 30

NUTRITION SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 11 a.m.—Conference on "The Nutritional Role of the Micro-Flora in the Alimentary Tract".

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at Caxton Hall, Westminster, London, S.W.1), at 2.30 p.m.—Discussion on "The Choice of Materials for Scientific Photography" (Papers by Dr. H. Baines and Mr. F. J. Tritton).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Harold Spencer Jones, F.R.S.: "Astronomy in our Daily Life", 2: "The Revolving Earth" (Christmas Lectures).

## APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ANALYTICAL CHEMIST FOR THE METALLURGY DIVISION of the National Physical Laboratory—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3304.A) (December 27).

DEMONSTRATOR or ASSISTANT LECTURER (temporary) in BOTANY—The Acting Registrar, The University, Leeds 2 (December 30).

SPEECH THERAPIST—The Director of Education, Education Offices, Woodlands Road, Middlesbrough (December 30).

TEACHER mainly for MATHEMATICS and ENGINEERING SCIENCE in the Junior Technical School and in Senior Day and Evening Classes—The Principal, County Technical College, Gainsborough, Lincs. (January 5).

ASSISTANT REGISTRAR—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (January 6).

RADIO DEVELOPMENT ENGINEERS for the laboratory of a large electrical engineering works in the N.W.—The Ministry of Labour and National Service, Central Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. A.736.XA) (January 11).

UNIVERSITY CHAIR OF CONCRETE TECHNOLOGY tenable at Imperial College of Science and Technology—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (February 26).

PROFESSOR OF MATHEMATICS, and a PROFESSOR OF CHEMISTRY—The Secretary, Queen's University, Belfast (March 31).

LECTURESHIP IN MORAL PHILOSOPHY AND THE HISTORY OF PHILOSOPHY (including Greek Philosophy)—The Secretary, Queen's University, Belfast (April 30).

SPEECH THERAPIST—The Education Officer, Town Hall, Chesterfield.

LABORATORY STEWARD IN THE DEPARTMENT OF PATHOLOGY—The Secretary and Registrar, The University, Bristol.

## REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

City and Guilds of London Institute. Report of the Council to the Members of the Institute for the Year 1943. Pp. xlix. (London: City and Guilds of London Institute.) [211

Religious Instruction in Schools. Preliminary Statement prepared by a Committee of representatives of the Joint Conference of Anglicans and Free Churchmen, the Association of Education Committees and the National Union of Teachers. Pp. 8. (London: National Union of Teachers.) [311

Britain and the World: an Outline of Reconstruction Problems. By the Hon. H. A. Wyndham. (Looking Forward Pamphlets, No. 1.) Pp. 60. (London and New York: Royal Institute of International Affairs.) 1*s.* net. [311

Ministry of Aircraft Production. A College of Aeronautics: Report of the Interdepartmental Committee on the Establishment of a School of Aeronautical Science. Pp. ii+98. (London: H.M. Stationery Office.) 2*s.* net. [711

Science in Post-Primary Education, with reference to the Scientific Education in Schools of Pupils of 11–18, and its relation to their subsequent Training in Universities and Colleges. Interim Report of a Sub-Committee of the Association of Women Science Teachers. Pp. vi+22. (London: John Murray.) 1*s.* 3*d.* net. [911

An Annotated Bibliography of Medical Mycology, 1943. Edited by Dr. S. P. Wiltshire, in collaboration with Dr. Charles Wilcocks and J. T. Duncan. Pp. 32. (Kew: Imperial Mycological Institute.) 5*s.* net. [911

Lighting Reconstruction Pamphlet, No. 5: Public Lighting in the City and Highway. Pp. 16. (London: Illuminating Engineering Society.) 1*s.* [911

Imperial Bureau of Pastures and Forage Crops. Bulletin 31: The Provision of Animal Fodder in Tropical and Subtropical Countries, Part 1. Pp. 84. 4*s.* Bulletin 32: Advances in Grassland Husbandry and Fodder Production, First Symposium. Pp. 108. 4*s.* (Aberystwyth: Imperial Bureau of Pastures and Forage Crops.) [911

Quality Control Chart Technique when Manufacturing to a Specification: with Special Reference to Articles Machined to Dimensional Tolerances. By Dr. B. P. Dudding and W. J. Jennett. Pp. iv+74. (London: General Electric Co., Ltd.) 2*s.* 6*d.* [911

Medical Science and Physical Education. A three-part Interim Report by the Reseach Board for the Correlation of Medical Science and Physical Education. Pp. xx+119. (London: Ling Physical Education Association.) 2*s.* [911

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 583. Vol. 231: A Revision of *Williamsoniella*. By T. M. Harris. Pp. 313–328+plates 25–26. 4*s.* 6*d.* No. 584. Vol. 231: On Large-scale Sample Surveys. By P. C. Mahalanobis. Pp. 329–451. 19*s.* (London: Cambridge University Press.) [911

Proceedings of a Conference on Problems in the Utilisation of Small Coals, held at the Institution of Civil Engineers, November 10th and 11th, 1943. Pp. 294. (London: British Coal Utilisation Research Association.) [1411

Iron and Steel Institute. Special Report No. 30: Ironmaking at the Appleby-Frodingham Works of the United Steel Companies, Ltd. By G. D. Elliot and the Staffs of the Appleby-Frodingham Ironworks, Scunthorpe, and of the Central Research Department, Stocksbridge (the United Steel Companies, Ltd.). Pp. vi+280+16 plates. (London: Iron and Steel Institute.) 16*s.* [1411

### Other Countries

Imperial Council of Agricultural Research. Miscellaneous Bulletin No. 58: Canning of Tomatoes in Baluchistan. By Dr. G. S. Siddappa and A. M. Mustafa. Pp. 4+2 plates. (Delhi: Manager of Publications.) 10 annas; 1*s.* [2710

Memoirs of the San Diego Society of Natural History. Vol. 2: The Geology and Paleontology of the Marine Pliocene of San Diego, California. Part 1: Geology. By Leo George Hertlein and U. S. Grant, IV. Pp. 72+18 plates. (San Diego: San Diego Society of Natural History.) 1.50 dollars. [3010

Publications of the Dominion Observatory, Ottawa. Vol. 13: Bibliography of Seismology, No. 14: Items 5564–5673, July to December 1943. By Ernest A. Hodgson. Pp. 231–252. (Ottawa: King's Printer.) 25 cents. [3010

British Honduras. Report of the Forest Department for the Year ended 31st December 1943. Pp. 10. (Belize: Forest Department.) [3010

Imperial Council of Agricultural Research. Scientific Monograph No. 15: Dry Farming in India. By N. V. Kanitkar. Pp. x+352. (Delhi: Manager of Publications.) 13.12 rupees; 21*s.* 6*d.* [211

Annals of the New York Academy of Sciences. Vol. 45, Art. 8: The Organization of the New York Academy of Sciences; its Incorporation, its Amended Charter, its Constitution and By-Laws, together with a Classified List of its Members. Revised to August 1, 1944. By Eunice Thomas Miner. Pp. 317–356. (New York: New York Academy of Sciences.) [711

Cawthron Institute, Nelson, New Zealand. Annual Report, 1943–4. Pp. 35. (Nelson: Cawthron Institute.) [711

State of California Department of Natural Resources: Division of Fish and Game, Bureau of Marine Fisheries. Fish Bulletin No. 59: The Commercial Fish Catch of California for the Years 1941 and 1942. By the Staff of the Bureau of Marine Fisheries. Pp. 68. (Sacramento: California State Printing Office.) [911

Brooklyn Botanic Garden Record. Vol. 33, No. 2: C. Stuart-Gager and the Brooklyn Botanic Garden. Pp. 69–178. (Brooklyn, N.Y.: Brooklyn Institute of Arts and Sciences.) [911

Bulletin of the American Museum of Natural History. Vol. 83, Art. 5: A Preliminary Study of the Thermal Requirements of Desert Reptiles. By Prof. Raymond Bridgman Cowles and Charles Mitchill Bogert. Pp. 261–296+plates 19–29. (New York: American Museum of Natural History.) [911

Academia Brasileira de Ciências. Symposium sôbre Raios Cósmicos, Rio de Janeiro, Agosto 4–8, 1941. Pp. 180+19 plates. (Rio de Janeiro: Academia Brasileira de Ciências.) [911

University of Colorado Studies. Series B: Studies in the Humanities, Vol. 2, No. 2: Fitz-James O'Brien, a Literary Bohemian of the Eighteen-Fifties. By Prof. Francis Wolle. Pp. xi+309. (Boulder, Colo.: University of Colorado.) 2 dollars. [911

Proceedings of the United States National Museum. Vol. 95, No. 3183: New Species of Buprestid Beetles from Trinidad. By W. S. Fisher. Pp. 397–410. (Washington, D.C.: Government Printing Office.) [1011

Smithsonian Institution: United States National Museum. Bulletin 185: Checklist of the Coleopterous Insects of Mexico, Central America, the West Indies and South America, Part 2. Compiled by Richard E. Blackwelder. Pp. iii+189–342. (Washington, D.C.: Government Printing Office.) 30 cents. [1011

# NATURE

No. 3922 SATURDAY, DECEMBER 30, 1944 Vol. 154


CONTENTS




*Editorial and Publishing Offices*

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# CIVIL SERVICE RECRUITMENT DURING THE RECONSTRUCTION PERIOD

THE report of the Committee of the Civil Service National Whitley Council on the staffing of the Civil Service during the reconstruction period, appointed in accordance with the Government's request as announced by the Chancellor of the Exchequer in the House of Commons on February 17, 1944, and containing proposals agreed between the official side and the staff side of the Council, has now been published*, under cover of a statement by the Government. The report proceeds on the basis envisaged in the Chancellor's statement that recruitment to the permanent service should begin at the earliest possible moment after the end of hostilities in Europe, continuing steadily throughout the reconstruction period, to provide for the required intake by departments of appropriately qualified men and women, and for the smooth transfer into permanent employment of those selected, whether from the Fighting Forces or otherwise.

In the covering statement the Government expresses its belief that public opinion will endorse the conclusion that, at the end of a war during which we have had total mobilization of man-power, a proposal to reserve all vacancies in the Civil Service exclusively for ex-Service candidates would be unfair to the rest of the community. The Government, however, is satisfied that the Committee's recommendation that, of the vacancies available for the reconstruction competitions, not less than 75 per cent in the administrative class, $66\frac{2}{3}$ per cent in the executive class, and 50 per cent in the clerical class should be filled by suitably qualified ex-service men, additional vacancies being reserved for ex-service women, constitutes the generous treatment that is essential, and the proposals in the report are commended to Parliament and to the public.

Like the Assheton Report on the training of Civil Servants, the recommendations of which have been accepted in principle by the Government, the present report is written almost entirely around the administrative, executive and clerical classes of the Civil Service. The importance of recruitment of well-qualified men and women to the professional, scientific and technical classes of the Civil Service is also recognized, and the Government states that departments employing these staffs are now engaged in formulating proposals for them which will, so far as possible, incorporate the principles already recommended for the general classes. It is expected that the matter will shortly be sufficiently advanced for discussion with the Civil Service staff representatives through the National Whitley Council. Meanwhile, the Government has decided to retain a central body of economists and statisticians, such as has been set up during the War in the Cabinet Offices. It is

* Recruitment to Established Posts in the Civil Service during the Reconstruction Period: Statement of Government Policy and Civil Service National Whitley Council Report. (Cmd. 6567.) Pp. 24. (London: H.M. Stationery Office, 1944.) 4*d*. net.

also stated that discussions are taking place in the National Whitley Council on problems that will arise on redundancy as the work of departments contracts, and on the question of any changes required in the main structure of the Service, such as the grades and classes, the methods of passing from one class to another, and the general arrangements to secure that the best use is made of all members of the staff. The flexibility of existing superannuation arrangements, the position of unestablished staff, and the effect of the new scheme of social insurance on the pensions of the public services have already received preliminary consideration.

The recommendations of the present report fall into two parts: those relating to "reconstruction competitions" and those relating to "normal competitions". The former are recommended primarily for those who have lost opportunities of competing for the Civil Service owing to the War, and the latter for those who reach the normal ages of entry as recruitment is re-opened.

The reconstruction competitions should extend over a period, so that the last man released from the Forces or other war service has as good a chance of competing as the first, and arrangements should be made to ensure that the late entrants suffer no disadvantage in pay. For vacancies accrued during the War by wastage and permanent expansion, the main source of recruits should be those who have missed their opportunity of competing for the Civil Service because of the interruption, that is, those within normal age limits plus the period of the War. Some of these vacancies should, however, be reserved for those above these limits but not older than thirty. In the administrative class there should be a common field of recruitment up to thirty years of age; in the executive, clerical and sub-clerical classes, one vacancy should be reserved for the older group of candidates for every four allotted to the younger group.

The reconstruction examinations should consist of written examinations in general subjects, plus an interview for the administrative and executive classes. Candidates should be required to possess certain minimum educational qualifications, namely, a university degree of at least second-class honours standard, or a year's continuous full-time university attendance and expectation of such a degree, for the administrative class; full-time education up to seventeen, or higher school certificate for the executive class; full-time education to sixteen or school certificate for the clerical class; full-time education up to fifteen for the sub-clerical class. Temporary Civil Servants should be subject to the same conditions as other candidates, with certain exceptions such as provision for the retention of specially selected senior temporary officers as principal, or analogous executive or departmental grades, or above, who are more than age thirty, and allotment of 15 per cent of the accrued vacancies in the basic executive and clerical grades to the best of the temporary officers in junior grades, above the age of thirty, who have at least two years of service (including any period of service with the Forces).

Established Civil Servants should be eligible for the reconstruction competitions, by which they may obtain promotion to a higher class. Very few of them will be able to comply with the minimum educational qualifications for the executive and administrative reconstruction competitions, and limited competitions should be provided against fixed quotas of vacancies in these classes, so as to restore their pre-war opportunities of sitting for the open competitions. All acting assistant principals promoted since the outbreak of war should be required to succeed in the limited competition before their promotions are confirmed.

Resumption of normal competitions is recommended concurrently with these reconstruction competitions, and candidates coming forward straight from school or university should be required to sit for a normal competition. These are proposed on the same lines as before the War, subject to the introduction of an interview for the executive class, a common examination for clerical assistants, typists and shorthand-typists, and, on an experimental basis, of a system of selection of a limited number of candidates for the administrative class mainly by interview by the Civil Service Commission. This last experiment is to be closely watched and reviewed after, say, ten years. Admission by this method should be confined to those who possess at least a good second-class honours degree.

These proposals, taken as a whole, seem eminently fair, in that they make provision for the entry into the Civil Service of those whose education has been interrupted by direction either to national service or the Fighting Services, and for the retention of those who have proved themselves, as temporary Civil Servants, to be exceptionally suited to their posts. The difficulties likely to arise through the necessity for spreading demobilization over a lengthy period are also foreseen. No guidance is given, however, on the precise methods of selection which are desirable, though no doubt the matter is under consideration; indeed, there is a hint to this effect in the suggestion that a certain number of candidates in normal competitions for the administrative class will be chosen mainly by interview.

The Civil Service Commissioners are facing a difficult task. Selection, in the main, will be by examination; but it does not follow that examinations of the stereotyped form will be adequate. There has been much criticism in the past few years of the methods and the personnel of the Civil Service: in particular, their devotion to precedence and the general lack, and even discouragement of, initiative, have been pilloried. To what extent the type of examination used to select candidates was responsible for the selection or development of this type of mind is difficult to assess, but there can be no question that the British Civil Servant of the future will need, in addition to the virtues which have been envied and admired by the corresponding services of other countries, a whole range of other abilities. As has been said repeatedly in these columns, he must be able to keep in touch with the feeling of the people

at large, he must have initiative, and, particularly in the administrative class, he must be able to interpret not only the letter but also the spirit of policy laid down by the Government. This, of course, raises the whole question of the status of the Civil Servant. The country will require for its administration the best brains available, and the Civil Service will have to attract, and hold, such ability in competition with industry and commerce. It is all to the good that this was so fully recognized in the House of Commons debate on December 14, when the report was warmly welcomed and endorsed.

# THE TREE ROOT AND THE SOIL

## Problems in Tree Nutrition

An Account of Researches concerned primarily with the Mycorrhizal Habit in relation to Forestry and with some Biological Aspects of Soil Fertility. By M. C. Rayner and W. Neilson-Jones. Pp. 184+27 plates. (London: Faber and Faber, Ltd., 1944.) 12*s*. 6*d*. net.

ONE of the most difficult problems, either in botany as a pure science, or in forestry as applied biology, has always been, and still is, to assess the relationships which exist between the root of a tree and its environment in the soil. The reason for this lies, of course, in the fundamental difficulty of observing the root under natural conditions without, at the same time, destroying its environment, or at least changing this in some radical manner. A secondary source of difficulty is also to be found in the need for a specialist's knowledge in making accurate observation of the micro-flora and -fauna of the soil, which form so important a part of the natural environment of the root. The consequence of this is to be seen in the relative neglect in general works on plant ecology of that part of plant associations which occurs below the ground, notwithstanding its admitted very great importance. The book under notice is concerned with the study of a special aspect of this relatively neglected subterranean field. Its topical interest lies herein, and especially in view of the wide interest aroused in the effect of composting on soil fertility—that is, on the value of the soil for root development—by Sir Albert Howard and others during recent years. The book consists of a collection of papers which have appeared at various times since 1934. They are here brought together with little or no alteration or editing and, with a short but excellent introduction, form the chapters of the book. A list of references, a glossary and an index are appended, and there is also a large number of plates illustrating the various papers.

The research work, the accounts of which are here collected together, will be well known to many foresters and botanists. It was begun in connexion with the afforestation of heathland near Wareham in Dorset. Much of this infertile tract of land had proved refractory for the growth of trees, principally pines, which had been sown or planted on it. In many parts growth was so disastrously inadequate that the condition of the trees was obviously pathological and a matter for much concern. Dr. Rayner, who initiated this research, put forward the hypothesis that the cause of this condition lay in the biotic relationships which occurred in the soil rather than in the admittedly low nutrient status as measured chemically; and that these relationships were expressed principally, so far as the trees were concerned, in the type of fungal association made by the root to form true or false mycorrhizas. Proceeding on this hypothesis, composts were prepared from materials such as hop waste and straw, and were added to the infertile Wareham soil. Conifer seedlings raised on such treated soil, whether in the forest or in the greenhouse, made normal vigorous growth and developed true mycorrhizas on their roots. Account had to be taken of the effect on growth of the nutrient salts added with the compost in order to distinguish between the effect of these and the organic matter. It was shown in a series of controlled experiments that the addition of equivalent amounts of nutrient salts by themselves to the heath soil failed to account in any adequate manner for the improvement in growth, both of shoot and root, obtained by composting. It was demonstrated that this improvement was related to the dominance in the soil of fungi such as *Boletus bovinus*, which form normal mycorrhizal associations; to a suppression of the fungi which form false mycorrhizal associations and to a marked increase in the number of short feeding roots. The differences between plants growing on treated and untreated soil and between normal and false mycorrhizas are well shown in the plates.

The biological aspects of soil fertility, in so far as they are illustrated by this work, are discussed in the interesting final paper. It is shown that the infertile heath soil contains a toxic substance, probably hydrogen sulphide, and that treatment which produces healthy growth results in the removal of this. The untreated soil is relatively inactive biotically, fungus activity being strongly depressed. Thus cellulose, such as filter paper, placed in it, shows very little tendency to decay. The reverse is true of soil treated with a suitable compost, in which fungi are very active. The toxic condition is worst in late winter: it is shown that this is correlated with high moisture content and not with low temperature.

This is a valuable and successful piece of work, the results of which are already being put to practical use. Its value is, perhaps, in no way greater than as a demonstration of the need of attempting to obtain a complete and unified view of the biotic association which is, in reality, being exploited in cultivation, and of which the crop plant is only a part, when trying to diagnose the factors responsible for any particular condition of growth. For fertility is the resultant of the interaction of all the factors of this association upon the crop plant. So far as forestry in particular is concerned, this work directs attention to the need for understanding the factors which determine the successful regeneration and maintenance of an adequate root system, especially during the first years after planting and also in the nursery. The rotation required to raise a utilizable forest crop may be lengthened very appreciably by slow unsatisfactory growth during early years. Technical measures for the alleviation of this state of affairs should be based on a knowledge of the adverse factors operating and not merely on guesswork, as has been too often the case in the past. Our knowledge of these matters at present is very slight, and it is highly desirable that further fundamental work should be encouraged. Much of this work will be concerned with the pathological rather than the normal development of plants, and not the least important aspect of the work under

review is the direction it must help to give to future studies of the pathology of the root system.

It remains to discuss the form and purpose of this publication. The book is an undoubted sign of the increasing interest being taken in land cultivation and especially in its scientific foundations. It is a present need of all who cultivate the soil that they shall understand adequately what they are trying to do, from a biological as well as from an economic aspect, for the two are indissolubly related. It is for these people rather than for the biological specialist that this book is, presumably, intended. If so, then it is doubtful whether in its present form it adequately fulfils the needs of the public it is desired to reach. The manner of compilation has resulted in a great deal of duplication of matter, which is rather tiring to the reader and by no means makes for clarity of exposition. The style of writing is also often difficult; this is partly because the papers were written for the instructed biologist with whom neither farmer, forester, nor horticulturalist is necessarily to be classed. No doubt the exigencies of the times made a re-writing of the work completely impossible; but it is to be hoped that at some future time the authors will be able to give a more connected and lucid account of the important relationships which exist between the root, the micro-flora of the soil and their physical environment. In the meantime, those who read through this series of papers will find much of interest and value. The many illustrations and the clear and well set out tables and text-figures are an undoubted help to their reading and understanding.

W. R. DAY.

## ELLIPTIC FUNCTIONS

### Jacobian Elliptic Functions

By Eric Harold Neville. Pp. xv+332. (Oxford: Clarendon Press; London: Oxford University Press, 1944.) 25s. net.

IN the preface to his "Elliptic Functions", written in 1892, Prof. A. G. Greenhill complained that, although the subject was then nearly seventy years old, it had not made its way into the ordinary curriculum of mathematical study in Great Britain. Fifty years later, in a lecture to the London Mathematical Society, Prof. E. H. Neville declared that, while his contemporaries at Cambridge thirty-five years ago would have regarded the elements of the theory of Jacobian elliptic functions as a subject which every undergraduate should study, the time had now come when the subject was largely neglected. He claimed that the study of Jacobian elliptic functions was being killed by the unnatural way in which the functions were introduced, and that every general principle was stifled by the lack of symmetry and the multitude of special formulæ. The book under review is his attempt to restore the Jacobian functions to their proper place in a university curriculum.

An elliptic function is a doubly-periodic meromorphic function of a complex variable $z$. The Argand plane is divided into a lattice of period-parallelograms, and the elliptic functions are functions defined on this lattice. The simplest elliptic functions are of order two; one type is the Weierstrass function $\wp(z)$, with a double pole in each cell; the other comprises the Jacobian functions with two simple poles per cell. While it is the case that $\wp(z)$ is defined directly on the lattice, the modern treatment of the Jacobian functions is not a direct one; the functions are introduced in an artificial way, undoubtedly the best way for the computer, by means of theta functions. In Prof. Neville's book, the Jacobian functions are defined directly by means of the Weierstrass function.

This is not entirely an innovation, but it is coupled with a new notation which exhibits the systematic and organic relations between the functions in a strikingly simple way. Writing $\omega_f, \omega_g, \omega_h$ for the half-periods $\omega_1$, $\omega_2$, $\omega_3$ of Weierstrass, Prof. Neville introduces three primitive elliptic functions defined by

$$\mathrm{pj}\, z = \sqrt{\{\wp(z) - e_p\}} \quad (p = f, g, h)$$

with the condition that the residue at $O$ is unity; then $\mathrm{pj}\, z$ has periods $4\omega_p$, $2\omega_q$, $2\omega_r$, a simple pole at $O$ and a simple zero at $\omega_p$. To complete the notation, he uses a symbol $\omega_j$ to represent the origin, and denotes the function with a simple zero at $\omega_p$, a simple pole at $\omega_q$, by $\mathrm{pq}\, z$. There are twelve functions in the complete set, and they are connected by the simple relations

$$\mathrm{pq}\, z \;\mathrm{qr}\, z = \mathrm{pq}\, \omega_r \;\mathrm{pr}\, z$$
$$\mathrm{pq}\, z \;\mathrm{qp}\, z = \mathrm{pq}'\, \omega_q$$
$$\mathrm{pj}^2 z = \mathrm{qj}^2 z + \mathrm{p}_q^{\,2}$$

where $\mathrm{p}_q$ is the value of $\mathrm{pj}\, \omega_q$.

The Jacobian function $u = \mathrm{sn}\, x$ was originally defined by the elliptic integral

$$x = \int_0^u \frac{du}{\sqrt{\{(1-u^2)(1-k^2u^2)\}}}.$$

To link up the new theory with the old, it is next shown that the relation

$$z = \int_0^w \frac{dw}{\sqrt{\{(g_f^{\,2} - w^2)(g_h^{\,2} - w^2)\}}}$$

is equivalent to $w = -\,\mathrm{jg}\, z$. Comparing these integrals, we see that with $z = x$, the relations are identical if $g_f = 1$, $g_h = -k$, $w = ku$. The actual dimensions and orientation of the lattice on which the primitive functions $\mathrm{pj}\, z$ are defined is immaterial because of their homogeneity in $z$ and the three periods. The condition $g = 1$ picks out of the whole family of similar lattices a special lattice called a Jacobian lattice. If the functions $\mathrm{pq}\, z$ are defined on a Jacobian lattice and are suitably normalized, they are simply the twelve Jacobian elliptic functions; in fact, $\mathrm{fj}\, z$, $\mathrm{gj}\, z$, $\mathrm{hj}\, z$ are the functions $\mathrm{cs}\, u$, $\mathrm{ns}\, u$ and $\mathrm{ds}\, u$ respectively.

Having now reached the customary notation, Prof. Neville again breaks with tradition. Instead of the usual quarter-periods $K$, $iK'$, $K + iK'$, he writes $K_c$, $K_n$ and $-\,K_d$, and uses $K_s$ as a symbol for the origin. This notation is likely to prove valuable, as it simplifies the whole presentation of the theory. For example, in the discussion of the transformations of Landen and Jacobi, the reader sees at once why the transformations work, as well as how.

It remains to complete the link with the definition of $\mathrm{sn}\, u$ by the inversion of an elliptic integral. This part of the book is very well written. It emphasizes clearly the nature of the problem, and gives a solution on entirely new lines.

In this review it has been possible to mention only the salient points of an excellent book. We hope that it will have the success it deserves, and that it will revive interest in this fascinating branch of analysis.

E. T. COPSON.

## The Navigator's Handbook on Modern Compass Adjusting

With particular reference to Wartime Conditions. By John Calder Gillie. Pp. 110. (London: George Allen and Unwin, Ltd., 1943.) 3*s*. 6*d*. net.

MR. GILLIE'S book contains within its small compass all the information necessary for those who wish to understand the factors on which the efficiency of the magnetic compass depends. Among its merits we may refer to its simplicity; it does not require a navigator to understand the nature of the problems. Although it cannot be considered a text-book for examination purposes, it will serve as an introduction to such books. Simple explanations are given regarding the effect of the steel of a ship on the compass, how the disturbing forces are divided into 'co-efficients', the means employed for making the necessary corrections, etc. The principle for degaussing installations—a matter of supreme importance in recent years—is simply explained and also their effect on the compass and the means adopted for overcoming their disturbance. Chapter 9 supplies some simple rules for dealing with compass troubles at sea, and a glossary and index are a useful addition to this highly commendable little book.

M. D.

## Principles of Powder Metallurgy

By Franz Skaupy. Translated by Dr. Marion Lee Taylor. Pp. 80. (New York: Philosophical Library, Inc., 1944.) 3 dollars.

IN view of the extreme interest being taken throughout the industrial world in the production of articles made from sintered metallic powders, a survey of existing knowledge of the fundamental principles involved is very much to be desired. Much of this information has been revealed by research, and the time has come when it should be collected and critically discussed.

Although the book is written by an author who has a considerable amount of original work to his credit, this volume does not, in the reviewer's opinion, perform this function. The general treatment is inadequate in view of the importance of the subject, and the English throughout is so bad that even after careful re-reading there are some sentences the exact meaning of which is still in doubt. It would not, for example, be immediately obvious that by "steam" (p. 20) the author is, in reality, referring to a metallic vapour.

F. C. THOMPSON.

## Science and Progress

By Dr. S. Lilley. (Story of Science Series.) Pp. iv+68. (London: Cobbett Publishing Co., Ltd., 1944.) 2*s*. 6*d*. net.

THIS book is one of a series projected by the Young Communist League. After directing attention to the ways in which science has changed the world's outlook, the author compares the progress of science under various forms of social structure—capitalism, Fascism and in the U.S.S.R. The last chapter deals with science and reconstruction after the War. Throughout the book the importance of organized scientific research is stressed. The author is convinced that this can only be adequately carried out under socialism, and he urges scientific men to fight for the best use of science "as a part of the organised Labour Movement". Half a crown seems a high price for such a propagandist pamphlet.

## The Riddle of Cancer

By Dr. Charles Oberling. Translated by Dr. William H. Woglom. Pp. viii+196. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1944.) 20*s*. net.

IT is often said, and with some reason, that the education of medical men is so specialized that they are turned out incapable of intelligible literary expression. The average book on a medical subject is seldom read with æsthetic pleasure. In "The Riddle of Cancer" we find the exception. To have presented the problems of cancer research in such a form that the survey is complete, lucid, interesting and not only valuable to the medical profession but also instructive to the inquiring layman, is a task for which the author and his translator deserve the highest praise. If standard medical text-books were only written in such a style, the student's work would be made vastly pleasanter.

The subject-matter covers the most important points in the whole field of experimental cancer research in some detail, and with particular reference to the carcinogenic viruses. A description of the general nature of viruses is included. The author is an exponent of the virus hypothesis, but his presentation of the work in other fields has not been allowed to suffer by his beliefs. There are a comprehensive bibliography and an index.

No doctor or medical student could fail to be edified by this fascinating exposition of a subject which is generally portrayed either luridly and inaccurately for the layman or at sombre, ponderous length for the expert.

## Chemical Industries

Edited by L. Ivanovszky. Nineteenth edition, enlarged and revised. Pp. xxviii+392. (London: Leonard Hill, Ltd., 1944.) 15*s*.

THIS edition of a useful publication has been enlarged in many sections. It includes a large number of detailed tables of physical data, properties of many kinds of materials, glossaries giving definitions of apparatus and products (with many clear diagrams), and ample sections on the most varied aspects of chemical engineering. The work is evidence of great skill in assembling and presenting valuable information in a concise form, and should prove of daily service in technical and other laboratories. The advertising material, which is quite separate from the text and takes up only a reasonable amount of the volume, is also instructive in character and likely to prove very useful.

## A Concise Pharmacology and Therapeutics of the More Important Drugs, together with an Introduction to the Art of Prescribing

By F. G. Hobart and Dr. G. Melton. Second edition. Pp. xvi+168. (London: Leonard Hill, Ltd., 1944.) 12*s*. 6*d*.

THIS is a compact survey of applied pharmacology which can be recommended as a reference book for students in the wards and preparing for examinations. It suffers in places by being so condensed that misinterpretation is possible. The apothecaries system of dosage is used almost exclusively even for drugs, such as those of the arsphenamine series, which are never prescribed in any but metric doses. Proprietary names of some drugs are included, and the examples chosen do not always include the one in commonest use.

# NOMENCLATURE PROBLEMS OF THE APPLIED BIOLOGIST

AT a meeting of the Association of Applied Biologists on November 10 a discussion took place on practical problems of botanical and zoological nomenclature. Dr. J. Ramsbottom (Department of Botany, British Museum (Natural History)), in opening the discussion, referred to the common but erroneous idea that systematists have as their main object the upsetting of established names. Paradoxical though it may seem, changes in scientific names are designed to achieve stability. The principle of priority is that the first validly published name for an organism is the one to be used. This principle is perfectly sound in theory, but its practical application is complicated by the fact that many names published in obscure journals are not rediscovered until years afterwards, when well-known names may have to be rejected in their favour.

The International Rules of Botanical Nomenclature permit of the conserving of well-established generic names under certain conditions; but proposals to conserve specific names have always been defeated in the past and are not likely to be accepted by any International Botanical Congress in the future. The conservation of a specific name would mean fixing the rank and genus of the plant concerned, regardless of subsequent research, which is incompatible with scientific taxonomy. On the other hand, a suggestion emanating from the Royal Horticultural Society to legalize the rejection of certain specified names may contain the germ of an idea which is workable and would achieve the same result in practice. The not unnatural desire of the economic botanist to have one name and one name only for any one plant is likewise incompatible with progress in taxonomy. A plant can have as many names as genera in which it has been placed. Genera may be split up into smaller genera or may be combined into larger genera; or a species may be reduced in rank to that of a variety. Homonyms provide another reason for change: sometimes it is found that the name of a well-known plant has previously been applied to some other species; a change must therefore be made.

To try to fix specific names it has often been proposed that standard lists of conserved names should be prepared. But it should be understood that no standard list can prevent changes of name caused by changes in classification.

Mr. G. R. Bisby (Imperial Mycological Institute) pointed out that mycologists have done little to deal with their special problems of nomenclature; the two articles of the International Rules applying particularly to fungi are still ambiguous and are variously interpreted, and no generic name of a fungus has yet been conserved. He suggested that there should be a permanent executive committee, with changing personnel, for the nomenclature of fungi; that this committee or some other should produce a shorter special code for mycological nomenclature, to apply under the International Rules; that users of names (including plant pathologists and various kinds of mycologists) should be given a chance to vote on proposals, such as the conservation of a few specific epithets, which affect them greatly; that specific epithets of fungi be decapitalized; and that the conservation of generic names be effected when necessary and desirable.

Mr. B. J. Rendle (Forest Products Research Laboratory) gave an account of what has been done in recent years towards stabilizing the names of timber trees. Workers in forestry and wood technology have suffered much inconvenience from changes in the names of common trees, most of them due to the application of the priority rule. Some bodies have found it expedient to fix certain well-known botanical names for their own use, in contravention of the International Rules. The reasons for doing so can be appreciated when it is remembered that trees are often cited by their botanical names in legislation, forest department regulations, contracts for timber concessions, specifications for timber and so on. A measure of stability has been achieved by the Empire Forestry Association and the British Standards Institution in drawing up a list of standard trade names of timbers with their correct botanical names. Over a period of about fifteen years this list has been repeatedly checked and revised, and is now as nearly correct as it can be.

It may not be generally known that the Sixth International Botanical Congress, in 1935, as a practical alternative to conserving specific names, adopted a motion "That an International Committee be appointed to draw up a list of names of economic plants according to the International Rules and that this list may remain in use for a period of ten years". It is understood that the work of this Committee was proceeding very satisfactorily until the outbreak of war; but since then it has been practically impossible to carry on, and much still remains to be done before the list is ready for publication.

Mr. A. Roebuck (Midland Agricultural College, Sutton Bonington) spoke feelingly from the point of view of an advisory agricultural entomologist. He deplored the frequent changes in the names of insects. To the field-worker it is the insect that matters; the name is of importance merely as a label or means of designation, so that one man can understand what another is talking or writing about. He quoted as an example a common insect pest which, in the course of a few years, has been placed in four different genera; much confusion has been caused to farmers in consequence. Genera are sometimes sub-divided on what appear to be insufficient grounds; for example, when three insects are difficult to separate into species, it seems unreasonable to place them in different genera. As a practical suggestion for stabilizing the names of economic insects, Mr. Roebuck advocated the use of English names for British insects, and suggested the preparation of a standard list giving the common names and the corresponding scientific names, the latter to be revised from time to time to keep pace with changes in taxonomic entomology.

Dr. I. Thomas (School of Agriculture, University College of North Wales), while supporting the claim that stability in nomenclature is incompatible with progress in taxonomy, was in favour of a standard list of Latin names of insects for the convenience of economic entomologists, provided that such a list were brought up to date at intervals of ten or twenty years. Periodic revision would provide the opportunity of asking the International Commission on Zoological Nomenclature to suspend the rules in cases where greater confusion than uniformity would result from a change. As an example of the confusion which may be caused by strict application of the law of priority, Dr. Thomas described what has recently happened in the family Aphidæ.

According to Hille Ris Lambers[1] the potato aphis *Macrosiphum solanifolii* (Ashmead, 1882) should now be designated *M. euphorbiæ* (Thomas, 1878). Unfortunately, Theobald stated that the species *solanifolii* Ash. was identical with *gei* (Koch, 1855) and the latter name, as a result of the application by Theobald of the law of priority, became well known in the literature. In all, Ris Lambers gives a list of twenty-four synonyms for this aphis. If it were possible easily to have the rules of nomenclature suspended in this instance, probably all economic entomologists would like to see the name *solanifolii* established. As a result of a discussion on the law of priority the Royal Entomological Society set up a Committee on Generic Nomenclature, but its lists are sometimes not accepted even by the authors of the lists themselves.

Entomological literature is still suffering from the effects of inadequate descriptions of proposed new species. Some of the descriptions given even in present-day literature are totally inadequate. All such work has to be sifted by the bona fide systematist, and it would considerably lighten his labours if something could be done to establish a minimum standard for publications.

Mr. Francis Hemming (secretary to the International Commission on Zoological Nomenclature) described the working of the International Code of Zoological Nomenclature. This was drawn up primarily by workers in systematic zoology in order to meet the needs of workers in that field, and unanimity was only achieved by placing a greater stress on the law of priority than had previously been intended. The International Code won a rapid acceptance among systematic zoologists, but owing to the rigidity of Article 25 (Law of Priority) difficulties were soon encountered, since the application of that Article led to well-known and well-established generic names being replaced by older but less well-known names. Objection was taken to such changes not only by numerous systematic zoologists but also by workers in applied biology, who argued that, whatever rules of nomenclature systematists might adopt for their own purposes, those rules should be such as to secure a reasonable degree of stability for important names widely used in the applied field.

The International Congress tried to meet this criticism at a meeting held at Graz in 1910, in which it was agreed in principle to establish an Official List of Generic Names in Zoology, with their type species. It was hoped that in this way it would be demonstrated that the Berlin Code of 1901 would secure stability for a wide range of important names, and therefore that the area of disagreement would be greatly narrowed. In 1913 at Monaco, the International Congress again considered this problem and decided to settle it by the grant (subject to certain safeguards) of plenary powers to the International Commission on Zoological Nomenclature to suspend the rules as applied to any given case where, in the judgment of the Commission, the strict application of the rules would clearly result in greater confusion than uniformity. It will be seen, therefore, that, as regards zoological names of importance either to workers in the applied field or to workers in systematic zoology, two valuable and important instruments have been placed in the hands of the International Commission in order to assist in the stabilizing of zoological nomenclature.

The International Commission is anxious to extend the Official List so as to include the names of all the most important genera in the animal kingdom. Arrangements are now being made for the early publication of the Official List, giving full bibliographical particulars relating to the names (between six and seven hundred in number) which have so far been admitted. The International Commission is hopeful that the publication of the Official List in this way will demonstrate the value of securing the admission of generic names to the List, and will stimulate specialists in various fields to submit proposals for further additions to the List. Applied biologists can be assured that, where any group of workers notifies the International Commission regarding names which they would like to see stabilized by admission to the Official List, the Commission, for its part, will do everything possible to meet their wishes in this matter. Here and there cases will no doubt arise where it will be found impossible to place some well-known name on the Official List without the Commission first suspending the rules in order to validate that name by suppressing some earlier name, or by fixing as the type of the genus some species other than that which is the type under the International Code. Where there are such cases, the sooner they are brought out into the open and settled once and for all, the better for all concerned.

In the general discussion which followed the more formal contributions, several speakers returned to the suggestion that for certain purposes common names are more convenient and more easily stabilized than scientific names. Standard lists of trade or common names, or more compendious works of reference such as the British Pharmacopœia, must necessarily give the corresponding scientific names in order to fix the identity of the organisms concerned; the scientific nomenclature can be kept up to date by periodic revision without affecting the common names. It was pointed out that although it is impracticable permanently to stabilize scientific names, the risk of confusion can be minimized by following some standard work of reference. It is open to any author of a paper or text-book, for example, to say in his introduction that he is using the names in the *n*th edition of such and such a standard work.

The discussion served to clarify the distinction between name-changes due to advances in taxonomy and those due to conventions such as the law of priority. No responsible body of biologists would seriously propose to limit improvements in classification by permanently stabilizing scientific names, though many would wish to see more careful consideration on the part of taxonomists before upsetting established names by minor changes in the rank of important economic plants and animals. Admittedly, the herbarium worker, dealing with very large numbers of specimens and continually striving towards the ideal system of classification, does not always appreciate the trouble which name-changes may cause to economic botanists concerned with a limited number of species. At the other extreme, the applied biologist, and still more the farmer or timber merchant trying to take an intelligent interest in the scientific aspect of his work, often fails to realize that a name is something more than a label, and condemns the name-changers as being uncompromising, academic and out of touch with realities.

There is a strong case to be made against name-changes which do not signify any progress in taxonomy, as when the resurrection of a prior name invalidates a well-known and old-established name. Botanists and zoologists attending the meeting were able to compare the merits of the international codes of

nomenclature for the two sciences with respect to this problem. The Botanical Rules provide for the conservation of generic names to avoid disadvantageous changes in nomenclature which might result from strict application of the Rules, but they do not permit of conserving specific epithets. Zoologists are perhaps more fortunate in that their standing International Commission on Nomenclature has plenary powers to suspend the rules in cases where their strict application would result in greater confusion than uniformity. Several suggestions were put forward by botanists to restrict changes due to the principle of priority, either by introducing a time limit for the reviving of an old name or by amending the rules so as to allow of the rejection of names which are clearly undesirable. A formal proposal that the Council of the Association of Applied Biologists should examine the question was carried without dissent. B. J. RENDLE.

[1] Hille Ris Lambers, D., *Temminckia*, 4, 84 (1939).

# GEOCHEMISTRY IN THE U.S.S.R.

By S. I. TOMKEIEFF

King's College, Newcastle upon Tyne

THE term 'geochemistry', like many other scientific terms, has a variable connotation. If geochemistry means simply the chemical study of the earth or parts of the earth, then geochemistry must be as old as chemistry itself, and dates from the attempts of Babylonian and Egyptian metal-workers and potters to understand the nature and properties of their materials. If, on the other hand, geochemistry is not only that, but something more, namely, an attempt to understand the distribution of chemical elements in the different parts of the earth, the migration of chemical elements and the laws of their combinations in the process of mineral formation, then geochemistry is indeed a young science. This is why the Russian geochemists claim that geochemistry is the science of the twentieth century. In saying that, they imply that science does not consist of a mere collection of data, but involves also theories and hypotheses which link up the data to form an organized whole; that a real science involves a definite mental technique in handling problems, setting up new points of view, and, in general, marshalling the results of experience. According to the Russian men of science, geochemistry is now passing from the stage of the 'data of geochemistry' to the 'science of geochemistry'; and from being a mere handmaid of mineralogy, petrology and economic geology, it is emerging as an autonomous science with its own problems, scope and methods.

A determined attempt to establish an autonomous science of geochemistry was made by Vernadsky, Fersman, Goldschmidt and Niggli, to mention only the four most prominent workers in this field. It is in Russia that geochemistry has taken deepest root, no doubt because of the widespread search for economic minerals and the scientific renaissance during the last two decades. Unfortunately, the intellectual isolation of the U.S.S.R. and the language barrier has made it difficult for scientific workers in other countries to become really acquainted with this movement.

The old descriptive mineralogy and descriptive petrology, which made such great strides during the last century, were predominantly static sciences. Many attempts at a genetic approach were made before Vernadsky, but perhaps it is to him that we owe its most forcible expression. He began in 1890 to break new ground in his lectures at the University of Moscow, and developed this work in his book on descriptive mineralogy[1], which began to appear in parts in 1908 and is still unfinished; for the surge of new ideas in the mind of the author led him to embark in 1925 on yet another serial work, the history of minerals[2]. Unfortunately, these books are not only left unfinished, but also their subject-matter is presented in such an inchoate form that they are difficult to follow. However, the author has managed to present his ideas more coherently and in application to more restricted problems in a book published in Russian, German and French[3]. In it we see a definite attempt to build a new geochemistry on the basis of the old mineralogy—an attempt full of daring ideas and schemes. It is a book that may shock an orthodox mineralogist and leave him bewildered and dazed. In spite of this, however, the book is very vivid and stimulating, and it suggests many new problems which, if followed up, may lead to some new fields of science. Vernadsky's next book is even more daring, for it deals with that still more complex realm, the biosphere, the sphere of life, full of complexities and change. By publishing this book, Vernadsky stimulated the study of what he called 'biogeochemistry'—the study of the chemical composition of the living matter in relation to the organically formed rocks. A biogeochemical laboratory was established in the U.S.S.R. and it soon became the thriving centre of a new research school

Vernadsky's younger contemporary, Fersman, began his lectures on geochemistry in Moscow's People's University in 1912. By that time he had already conceived the idea of a book which would not only include all the data of geochemistry, but also present a synoptic view of the whole subject. It is important to note here that Fersman, like Vernadsky, being a first-class mineralogist, made the approach to geochemistry from the side of mineralogy. His main interest at that time was concentrated on regional mineralogy, or as he called it 'topomineralogy', and in 1922 he published the first part of his ambitious work on the geochemistry of Russia[5], which was left unfinished under the stress of the new ideas which emerged from it. In this book he used regional mineralogy only as a basis for a superstructure of geochemistry. His mineral assemblages became genetic types, mineral provinces became geochemical provinces, and these in their turn were incorporated into geospheres, the whole being linked up into unending genetic cycles. In this way genetic mineralogy and genetic petrology became incorporated into the all-embracing geochemistry. Not satisfied with geospheres and the unknown centrosphere, Fersman overflowed into the cosmos, incorporating the sun, the stars and the meteorites, merging geochemistry into cosmochemistry. These ideas were fully developed by him in his next book, published in 1923[6].

Not only interested in the distribution of the chemical elements in the geospheres and in the cosmos, Fersman made an attempt to find the causes of such a distribution. Following up the guiding ideas of De Launay and Goldschmidt, he tried to connect up the distribution of the chemical elements and their atomic structure, first in a series of papers and later in a monumental work of more than 1,500 pages entitled "Geochemistry"[7]. The main body of this work is contained in the first three volumes; the

fourth volume provides reference tables and geochemical data for all the chemical elements. A fifth volume, which was announced, was replaced by a separate publication dealing with applied geochemistry[8].

Already in 1922 Fersman emphasized that the main purpose of geochemistry is not merely the chemical study of minerals and rocks, but also the study of the distribution and migration of chemical elements in the earth. In his book on geochemistry, Fersman defines the aim and the scope of this science even more precisely. "The purpose of geochemistry is the study of the element-atom in the conditions prevailing in the earth's crust (as well as in the parts of the cosmos accessible to our exact observations). Geochemistry studies: (*a*) the quantitative distribution of the chemical elements in the earth's crust and their dispersion and local concentration; (*b*) the combinations of different elements in the different parts of the earth's crust and their distribution in space and time under the influence of different chemical processes; (*c*) the migration of elements and the laws of such migration as determined by the different thermodynamic conditions of their environment; and (*d*) the behaviour of chemical elements either in the environment of the earth's crust or as compounds and particularly as crystals. This may be expressed even more simply: geochemistry studies the history of chemical elements in the earth's crust and their behaviour under different thermodynamic and physico-chemical natural conditions".

Taking the dictum of Lomonosov—"From observation follows theory, theory corrects observation"—as his motto, Fersman packs his book with data culled from all possible sources, and gives an imposing list of references to the literature in all languages. The observational or experimental data is used by him for the construction of far-reaching theories, or, as some may say, hypotheses. A host of new and daring ideas spring into existence and enmesh his array of facts. These new ideas often necessitate the invention of new terms, and an ordinary mineralogist or chemist may be greatly puzzled meeting terms such as *EK*, *VEK*, clarke, paragene, co-centre eutectite, orthotectite, etc. Here is the explanation of some of his key-terms: clarke (in honour of F. W. Clarke, the author of "The Data of Geochemistry") is the average quantity of a given element in any geochemical system; *EK* (energy coefficient) is an index expressed in calories per gram-mol at 0° Abs., showing the amount of energy contributed to a heteropolar compound by the transfer of an ion from infinity to its present position in the crystalline lattice; *EK*'s are calculated from the energy of the crystal lattice, but an approximate formula gives $EK = Kw^2/2R$, in which $K$ is a coefficient (almost equal to unity for anions), $w$ is valency, $R$ is ionic radius; *VEK* is *EK* divided by valency, or the energy per valency of an ion; paragene is a complex and as yet undetermined function depending on the crystal chemical constants and energy coefficients. It is suggested that the paragene, when properly determined, may fix the relative position of a compound (mineral) in the paragenetic succession.

The field covered by geochemistry as outlined by Fersman is most extensive. It includes all systematic mineralogy and petrology, the study of ore deposits, crystal-chemistry and physical chemistry as applied to natural processes. All these sciences are combined into a unified scheme following definite leading ideas. In his book on geochemistry, Fersman begins with the consideration of chemical elements and then passes to crystals, geospheres, migration of chemical elements, clarkes, geochemical processes and geochemical types. At a later stage a detailed examination of the periodic system is undertaken in the light of atomic structure and crystal-chemistry, and also a detailed treatment of energetics as applied to geochemistry, including the energy of the crystal lattice, energy coefficients (*EK* and *VEK*) and the principle of the paragene. Fersman's main idea is that the energy coefficients of ions provide the fundamental ground for the understanding of all geochemical processes: "The course of a natural process and the association of minerals and elements in space and time are determined by the law of the decrease of the space-lattice energy. The application of *EK*'s, for example, the energy of simple and complex ions forming the lattice, provides an important key for the solution of geochemical problems from the point of view of energetics".

This application of 'geoenergetic analysis' to all geochemical problems is most clearly marked in his treatment of pegmatites—coarse-grained rocks crystallized out of a water-rich rest magma during the later stages of magmatic consolidation. Fersman has been engaged in the study of pegmatites during the last thirty years, and has published a number of papers on this subject. In 1931 he published a large book on granite-pegmatites, a third, revised and enlarged edition of which appeared in 1940[9]. This is to be followed by another work dealing with syenite-pegmatites. The book on granite-pegmatites is packed with data culled from all parts of the world, including many new observations on pegmatites in the U.S.S.R. The factual data are interpreted according to a definite genetic scheme, and all types of pegmatites are considered as members of a continuous series corresponding to the stages of the cooling of granitic magma. The chronological sequence of these stages is as follows: (1) magmatic (900°–800° C.), (2) epimagmatic (800°–600°), (3) pneumatolytic (600°–400°), (4) hydrothermal (400°–50°), (5) hypogenic (50°–0°). Each stage is characterized by a more or less definite mineral assemblage in a given type of pegmatite. The main concern of Fersman is to find the cause or causes of this association and succession of minerals (paragenesis). A suggestion is made by him that minerals with a high lattice-energy crystallize out first, but this is complicated by other factors, such as the composition of the melt, the amount of volatiles, the nature of the ions present and many others. The book on granite-pegmatites is definitely a work on the geochemistry of these rocks, and it provides a test piece for his geochemical theories as applied to magmatic rocks. At the same time, a systematic description of pegmatites of the U.S.S.R. has been undertaken in a series of monographs, two of them already published[10]. Pegmatites contain a number of economically valuable minerals and such a survey is of great practical importance.

The new school of geochemistry has made and is making rapid progress in the U.S.S.R. It was fostered by the formation in 1931 of the Institute of Geochemistry, a research institute forming part of the Lomonosov Institute at the Academy of Sciences. The Lomonosov Institute (named in honour of the great Russian scientist, M. V. Lomonosov, 1711–65), occupies a large new building in Moscow and houses a great number of research workers, many of them

engaged on problems of economic importance. As an example of such work one may mention a recent publication on the geochemistry of gold by Zviaginzev[11]. In this book the author gives an account of the distribution and migration of gold in geospheres, and traces the history of gold from its concentration in hydrothermal veins to its renewed concentration in placers. Several interesting problems are discussed, such, for example, as the occurrence of gold in meteorites, in water, in plants and in coal. The concentration of gold in the hands of man (anthroposphere) is estimated to be of the order of 0·001 per cent of the total amount in the earth.

It is difficult to avoid the impression that geochemistry in the U.S.S.R. tends to the fanciful, and the criticism so implied is not altogether unjustified. It must, however, be noted that Russian geochemists have done and are doing much spadework, and that ideas and theories, which may have seemed extravagant, have proved valuable both in the co-ordination of knowledge already acquired and in the search for knowledge as yet unrevealed. In this branch of science, as in others, progress depends on daring thrusts into the unknown, on the blazing of new trails which must later be consolidated by patient experimental and observational work.


[1] Vernadsky, V. I., "Essay on Descriptive Mineralogy" (St. Petersbourg, 1908–10), 1, Parts 1–3.

[2] Vernadsky, V. I., "History of Minerals of the Earth's Crust" (Leningrad, 1925), 1, Part 1, 1933, 2, Part 1.

[3] Vernadsky, W., "La geochimie" (Paris, 1924).

[4] Vernadsky, W., "La biosphere" (Paris, 1929).

[5] Fersman, A. E., "Geochemistry of Russia" (Petrograd, 1922), Part 1.

[6] Fersman, A. E., "Chemical Elements of the Earth and the Cosmos" (Peterburg, 1923).

[7] Fersman, A. E., "Geochemistry" (Leningrad), 1 (1933), 2, (1934). 3 (1937), 4 (1939).

[8] Fersman, A. E., "The Search for Mineral Deposits on the Basis of Geochemistry and Mineralogy" (Moscow, 1939).

[9] Fersman, A. E., "Pegmatites". 1, "Granite Pegmatites" (Leningrad), 1st edit. (1931); 2nd edit. (1932); 3rd edit. (1940).

[10] "Pegmatites of U.S.S.R.", Edited by A. E. Fersman and I. I. Ginsburg (Moscow), 1 (1936); 2 (1939).

[11] Zviaginzev, O. E., "The Geochemistry of Gold" (Moscow, 1941).

(With the exception of 3 and 4, all these publications are in Russian.)


## CRYSTAL DYNAMICS

THE subject of crystal dynamics, which is concerned with the vibrational movement of atoms in the solid state, is now of respectable antiquity. The classic papers are perhaps those of Einstein[1], Debye[2] and Born and v. Kármán[3], which deduce the specific heat of metals from the vibrational energy of the crystal lattice. The whole subject has recently received a new interest and stimulus by the discovery that the thermal vibrations of the atoms of a crystal produce measurable effects in the background of X-ray diffraction patterns. The normal Bragg-Laue diffraction pattern of a crystal is characteristic of its geometry: the thermal motion of the atoms appears as a pattern in the background of the diffraction photographs. This is a subject which evidently has wide ramifications, and in fact must ultimately affect every branch of physics concerned with the solid state of matter. The experimental and theoretical development of the subject have been ably summarized by Lonsdale[4] and Born[5].

That ideas concerning the vibrations of so complex a system as a crystal lattice should depend to some extent on the mode of approach to the problem is perhaps to be expected, but the extent to which they diverge is surprising. Sir C. V. Raman approaches the matter, naturally, by a road leading from the optical characteristics of transparent crystals: such phenomena as the Raman effect, luminescence and absorption spectra should throw light on the nature of vibrations in the crystal lattice. Recently there has appeared "A Symposium of Papers on the Dynamics of Crystal Lattices"[6], in which Raman develops his ideas about the atomic vibrations in a crystal, while his collaborators extend his ideas in several directions.

The basic fact which the theory seeks to explain is that the Raman spectra and luminescent spectra of crystals consist of a number of discrete monochromatic lines. That these lines are superimposed on a continuous background of intensity is ignored. To provide an explanation for the discrete lines in the spectra Raman seeks to endow the crystal lattice with a limited number of discrete modes of vibration. The absorption of energy from the incident beam by one of these modes would give an absorption line, while the communication of energy from one of the modes would give an emission line in the emission spectrum.

Raman's argument seems to run as follows. Directing our attention to a particular atom in a particular crystal cell, we see that the restoring force which operates when it is displaced from its position of equilibrium is the same as that which acts on any crystallographically equivalent atom in any other cell of the crystal, because all these equivalent atoms have the same kind of neighbours arranged in the same pattern. This identity of the force constants suggests that the displacements of equivalent atoms in a normal mode of vibration are related in a simple way. Raman is then led to the result that equivalent atoms in the crystal have all the same amplitude of vibration, their phases being either the same or opposite in neighbouring cells along the three crystal axes. This means that the atomic vibrations repeat themselves in a space pattern of which the unit has twice the linear dimensions, and therefore eight times the volume, of the unit cell of the crystal lattice. If there are $p$ atoms in the unit cell of the crystal, there are $8p$ atoms in the superlattice cell into which the vibrations divide the lattice. Each of these $8p$ atoms has three degrees of freedom, so the total number of normal modes is $24p$, three of which correspond to translations of the crystal as a whole and do not rank as modes of vibration of the lattice. The total number of frequencies so enumerated will also be reduced by the symmetry of the crystal structure.

The foregoing argument thus leads to the result that the vibrational spectrum of the crystal consists of a small number of discrete (monochromatic) frequencies. The result is founded on an arbitrary assumption and is quite at variance with all other work on the subject. Raman concludes his paper with some (unfortunate) remarks about Born's "postulate of the cyclic lattice", an idea which both Born and Lederman[7] have re-examined and found to be justifiable.

The remainder of the symposium consists, on the theoretical side, of four papers by E. V. Chelam on the enumeration of the normal modes of vibration of several types of cubic lattice, and two papers by G. N. Ramachandran on the vibrations of the fourteen Bravais lattices. The experimental background, which the theory is designed to explain, is reviewed by R. S. Krishnan, who deals with the Raman effect in crystals, and by D. O. Pant, who surveys the experimental data concerning the luminescent spectra of crystals. It is unfortunate that these

authors and their eminent leader have not given their careful attention to the X-ray evidence which has been so well described by Dr. Kathleen Lonsdale. This demands a nearly continuous spectrum of vibrational frequencies in the crystal quite contrary to Raman's theory. Krishnan, moreover, ignores the continuous background to the Raman spectrum of sodium chloride observed by Fermi and Rasetti[8] and stresses only the lines which are superimposed on the background. The lattice theory developed by Born (*loc. cit.*, p. 309) provides an explanation of the X-ray results and also of the small number of lines in the Raman and absorption spectra of crystals. There does not, therefore, seem to be any necessity for introducing arbitrary assumptions into the dynamical theory in order to reduce the number of normal modes of vibration to a few discrete frequencies. G. D. PRESTON.

[1] Einstein, *Ann. Phys.*, 22, 180 (1907).
[2] Debye, *Ann. Phys.*, 39, 789 (1912).
[3] Born and v. Kármán, *Phys. Z.*, 13, 297 (1912).
[4] Lonsdale, Reports on Progress in Physics, 9, 256 (1943).
[5] Born, Reports on Progress in Physics, 9, 294 (1943).
[6] Raman and others, *Proc. Indian Acad. Sci. Bangalore*, 1–102 (1943).
[7] Lederman, *Proc. Roy. Soc.*, A, 182, 362 (1944).
[8] Fermi and Rasetti, *Z. Phys.*, 71, 689 (1931).

# OBITUARIES

## Sir Joseph Arkwright, F.R.S.

JOSEPH ARTHUR ARKWRIGHT, an honorary member of the staff of the Lister Institute of Preventive Medicine and a former member of the Medical Research Council and of the Agricultural Research Council, died on November 22 after a short illness, a few weeks after the death of his friend and colleague, Sir John Ledingham. He was the son of the late Arthur William Arkwright, of Broughton Astley, Leicestershire, and was born on March 22, 1864. He was educated at Wellington College, and Trinity College, Cambridge, and pursued his medical studies at St. Bartholomew's Hospital, London, qualifying in 1889 and graduating M.D. in 1895.

Arkwright had a many-sided and distinguished career. After postgraduate work at St. Bartholomew's, the Victoria Hospital for Children, Chelsea, and the West London Hospital, he engaged for some years in general practice, chiefly at Hales Owen, Worcestershire; but in 1905 he renounced this work to join the staff of the Lister Institute, first as a voluntary research worker and from 1909 onwards as assistant bacteriologist. He retired from active duty in 1927, but continued to work at Chelsea as an honorary member of the staff. He was elected a member of the governing body of the Institute in 1932 as the representative of the Royal Society and served until January 1 of this year, when the Board recorded its high appreciation of the value of his wise counsel during the period of his service.

Arkwright's work at Chelsea was interrupted by the War of 1914–18 when, after investigating an epidemic of cerebro-spinal meningitis among troops encamped on Salisbury Plain in 1915 and recording his observations on the grouping of meningococcus strains that were isolated, he served in the R.A.M.C. with the rank of major as pathologist at St. George's Hospital, Malta, where with Dr. E. A. Lepper he investigated the occurrence of blackwater fever in the Eastern Mediterranean area. In 1918 he was appointed a member of the War Office Committee on Trench Fever, and with his colleagues, Bacot and Duncan, demonstrated the constant association of the virus of trench fever with *Rickettsia quintana* in lice. In 1922 he accompanied Bacot to Egypt at the request of the Egyptian Government, to investigate the etiology of typhus fever. After two months work in Cairo, both contracted the disease, to which Bacot unfortunately succumbed; Arkwright recovered from a severe and hazardous illness. Previously, in 1920, he had carried out a series of investigations on foot-and-mouth disease under the auspices of a committee appointed by the Ministry of Agriculture and Fisheries and later became chairman of this committee, as also of the Agricultural Research Council's *Brucella abortus* Committee and the joint committee with the Medical Research Council on tuberculosis.

The subject, however, with which Arkwright's name will always be associated is that of bacterial variation, and his fundamental and luminous researches on the forms of bacteria that he named the "S" and "R" variants, embodied in an outstanding communication to the *Journal of Pathology and Bacteriology* in 1921, gave a new impetus to research in this direction. He was also deeply interested in the carrier problem, and his book, "The Carrier Problem in Disease", published in collaboration with the late Sir John Ledingham, was an important contribution to this subject. He also contributed freely to the Medical Research Council's "System of Bacteriology" and to numerous scientific journals.

Arkwright's active and versatile mind found many channels for its expression. He was appointed a member of the Medical Research Council in 1930 and of the Agricultural Research Council on its inception in 1931. His public-spirited and useful work in these directions only terminated in 1940, when in his seventy-sixth year he retired from the latter of these offices. He was made a fellow of the Royal College of Physicians in 1916 and served on the Council during 1929–31. He was elected a fellow of the Royal Society in 1926, and the honour of knighthood was bestowed on him in 1937 for his outstanding scientific achievements.

Arkwright had a charming personality and extended an ever-helping hand to the younger workers at the Lister Institute, to whom he was a source of encouragement and inspiration. Apart from his special studies he had a broad cultural and scientific background and was a field naturalist of no mean ability, possessing an exceptional knowledge of field botany and of horticulture, and a good working knowledge of other branches of natural science. He married in 1893 Ruth, daughter of the late Joseph W. Wilson, who, with their three daughters, survives him. R. ST. JOHN-BROOKS.

## Dr. G. A. Tomlinson

WE regret to record the death of Dr. George Arthur Tomlinson, a principal scientific officer at the National Physical Laboratory, on December 1, after a short illness.

Tomlinson was born on January 7, 1885, and educated at Nottingham High School, passing on to University College, Nottingham, where he took the degree of B.Sc. (London) in engineering, with first-class honours. He then spent two years as a research student at St. John's College, Cambridge, on post-graduate research. He also gained honours in electrical engineering in the City and Guilds (London) exam-

ination. On leaving Cambridge he worked for a time with Messrs. Kelvin and James White, of Glasgow, on researches relating to electrical and magnetic problems. Later he held, in turn, lectureships in electrical engineering at the Rutherford Technical College, Newcastle-on-Tyne, and at the Borough Polytechnic, London.

In 1915 Tomlinson was appointed to a post at the National Physical Laboratory, where he was first engaged, during the War of 1914–18, on the verification of gauges. From this he turned his attention to devising apparatus for the measurement of gears and gear-cutting hobs, then almost a new field, with which he continued to be closely associated for the rest of his life, developing further methods and instruments for checking the accuracy of gears of all sizes, and of the hobbing machines used in their production. In this subject he became a recognized expert whose advice was sought both by government departments and by private firms.

Among other matters Tomlinson also devoted himself successfully to the study of molecular cohesion in relation to surface phenomena such as pressure corrosion and friction. Following this, he became interested in the geometrical properties of surfaces, and devised the now well-known surface-finish recorder which bears his name, and which is an excellent example of his direct attack on a problem, and his faculty for attaining results by the simplest means.

An altogether different line of work was in connexion with the improvement of time-keepers. He spent much time on the development of a new type of vibration clock, and in experiments on new methods for driving free pendulum clocks. Incidentally to this work, he designed a new type of chronograph for the comparison of time-signals to an accuracy of 0·1 millisecond.

Tomlinson had a flair for instrument design which amounted to genius. More often than not he would make the first model of a new instrument with his own hands, using the material nearest to hand. But though these first models might have a somewhat gimcrack appearance they were always usable tools and, being usually designed to meet some immediate need, were often put into practical service for considerable periods before, as happened in many cases, their proved utility made it desirable to re-design them in a form suitable for commercial production.

Tomlinson—"Tommy" to his friends—had a charming and lovable personality. Modest and unassuming, he was always ready with advice and help for others, and a source of inspiration to those who worked with him. He was a rare combination of man of science and practical engineer, and his death is a national loss. He leaves a widow and two sons.

J. E. SEARS.

## Dr. J. N. Sugden

DR. JAMES N. SUGDEN, senior lecturer in inorganic chemistry in the Imperial College of Science and Technology, who was killed by a flying bomb on July 11, 1944, was born at Silsden, near Keighley, on March 27, 1894. As a pupil of the Trade and Grammar School, Keighley, he came under the influence of a former student of chemistry in the Royal College of Science, Mr. Harry Harper, and after a period of study at the Technical College, Huddersfield, he proceeded to South Kensington in 1913.

Having graduated as an associate with first-class honours, and having been awarded the Neil Arnott Studentship and a Royal Scholarship, Sugden devoted himself to investigations which naturally soon became closely related to war problems. He received a commission in the Army, and under the direction of the late Prof. H. Brereton Baker he took part in some of the early scientific work which arose out of the enemy's use of poison gas. Later he was much concerned with the technical development of methods and equipment for ensuring an adequate supply of safe drinking water for troops dependent on contaminated supplies, particularly in France and in Mesopotamia. Under his immediate supervision, large mobile and static chlorination plants with their control laboratories were designed, tested, dispatched, and operated. Returning in 1919 from a prolonged visit to Iraq, he was appointed a demonstrator in chemistry at the Royal College of Science (Imperial College of Science and Technology); he was promoted to be a lecturer in 1922, and senior lecturer in 1943. There he quickly established a reputation as a most conscientious and efficient teacher.

Sugden's methods were often ingenious, and sometimes unorthodox; for he was an individualist whose acidulated epigrams were a tonic to the laggard, but whose meticulous care and patient instruction were an inspiration to every diligent student. Prolonged ill-health restricted the scope of his physical activity, but his mind seemed the more acute. His principal contribution to chemical knowledge concerned the hydration of salts in aqueous solution. This study yielded most interesting results; but he placed his teaching duties before all other attractions, and never regained the physical strength to pursue the inquiry.

Sugden was not an easy man to know. His bachelor life was lonely, and his friends, deliberately few, scattered by the march of time. He was interested in British silver coins, and liked to try his hand at the more erudite literary competitions in periodicals, especially those involving a foreign language. He was a judge of burgundy, and his efforts as an amateur photographer disclosed an artistic perception. While few could phrase a rebuke more mordantly, few enjoyed more gloomily the humour of life or more often delighted their acquaintances with gleanings among the unusual, the comic, or the profound. By his colleagues, as well as by many of the students to whom he ministered for twenty-five years, he will be remembered with affection and with the respect due to one who, having well considered, possessed the courage of his convictions.

A. A. ELDRIDGE.

## Prof. B. B. Ray

PROF. B. B. RAY, Khaira professor of physics in the University of Calcutta, died on July 29, 1944. He was a fellow of the National Institute of Sciences of India; and presided over the Physics Section of the twenty-ninth session of the Indian Science Congress, held at Baroda in 1942. Prof. Ray joined the University of Calcutta in 1921 as a lecturer in physics and was one of the early batch of students who carried out research work in physics under Sir C. V. Raman.

Prof. Ray visited Europe twice, once in 1923 and again in 1935. During his first visit he worked at Uppsala in the laboratory of Prof. M. Siegbahn and at Copenhagen under Prof. Niels Bohr. It was in Prof. Siegbahn's laboratory that Prof. Ray learned

the technique of research on X-ray spectra. On his return to India he devoted himself to founding an active school of research on X-rays.

In 1935, he was elected to the Khaira chair of physics in the University of Calcutta.

Immediately before his death, Prof. Ray was carrying out researches on the absorption and emission spectra in the soft X-ray region. He was also conducting investigations on the luminescence of solids under X-ray bombardment. Prof. Ray had a charming and lovable personality and was very popular with his students. Science in India has suffered a great loss by his untimely death at the early age of fifty.

WE regret to announce the following deaths:

Prof. Edward F. Berry, professor of civil engineering at Syracuse University, on August 28, aged fifty-four.

Prof. E. F. Gaines, professor of genetics in agronomy and cerealist in the Agricultural Experiment Station of the State College of Washington, known for his work on the inheritance of disease resistance in cereals, on August 17, aged fifty-eight.

Dr. Walter L. Jennings, formerly professor of chemistry and later director of the Worcester Polytechnic Institute, Massachusetts, on September 2, aged seventy-seven.

# NEWS and VIEWS

## Royal Institute of International Affairs

THE annual report of the Council of the Royal Institute of International Affairs for the year ended June 30, 1944, gives a brief review of the growth of the work since the Institute was established in 1919 for the scientific study of international affairs. A committee was appointed by the Council on April 19, 1944, to review the developments of a quarter of a century, "to re-examine the purposes for which the Institute was founded; to inquire whether any change is desirable in the present activities of Chatham House, or any shift of emphasis in order to increase its influence and value". Researches into international problems published during these twenty-five years appearing in the growing list of volumes under the auspices of the Institute have already placed Chatham House on a footing comparable with the national institutions established in other fields. Strict adherence to the basic rule that the Institute should express no corporate opinion on any aspect of international affairs has contributed in no small measure to recognition of its integrity and to the attainment of its present position. Means of study have been provided for the serious student of international affairs. The Library is the most comprehensive collection of its kind in England, and has overflowed from its cramped quarters into more ample reading rooms. The Press archives are unique, and after the War, when these archives are returned to Chatham House by the Foreign Office Research Department and again become generally available, they will be a source of information that will attract scholars from all over the world.

With regard to the past year, the report refers to the opening on May 17, 1944, of the additional premises at 9 St. James's Square, London, the re-publication in January 1944 of *International Affairs* as a quarterly, by arranging for printing in Canada, and the opening in New York on February 1 of a Publications Office for distribution of the Institute's publications, and to the continuance of week-end courses on international affairs for officers and men of the Forces. A list of the fourteen courses arranged is appended, and the 300 available places at each were allocated among the Royal Navy, the British Army, Royal Air Force, Canadian Army and U.S. Army. The "British Year-Book of International Law", which was suspended at the outbreak of war, is to re-appear shortly as a Chatham House publication covering the period 1940–43. Reconstruction studies have continued, but only one report, "The International Secretariat of the Future", was published during the year. A preliminary report of the group dealing with economic and social problems will be published shortly under the title "The Economic Lessons of the Nineteen-Thirties", as well as a series of pamphlets under the title "Looking Forward" to assist members of the general public to form their opinions on some of the principal international problems of reconstruction. One of these, by Dr. C. H. Desch, deals with "Science and the Social Order". Lists of individual studies published during the year, in the press or in progress are included; with notes on Far Eastern studies and the Institute of Pacific Relations, British Commonwealth relations, Allied research in London and on the work of the branches and of the institutes in the Dominions and in India.

## Town and Country Planning in Britain

BULLETIN No. 4 of the Tory Reform Committee deals with "Government Policy for the Rebuilding of Urban Areas" as set forth in the Town and Country Planning Act, of which it gives a concise exposition. Development in Great Britain has hitherto been haphazard, uneconomical and unplanned for five reasons. The planning authorities have always been too small and there has been no central machinery co-ordinating local schemes in accordance with a national policy. Any planning authority inclined to take a less parochial view met financial difficulties resulting from its small size. Urban authorities were similarly penalized if they sought to make an enlightened dispersal of their population, because this meant handing rateable value to neighbouring authorities. Again, just where dispersal was most needed, land values rose sharply in proportion to the need for using the land. Compulsory acquisition by an authority was made slow, difficult and costly by the old piecemeal procedure.

The Tory Reform Committee holds that there can be no doubt that the elimination of all local inquiries, except in special cases, as was recommended by the Uthwatt Committee, would greatly expedite the compulsory acquisition of land, but it would be impossible to justify the compulsory purchase of the property of individuals without giving them an adequate opportunity of stating their objections. Again, it would be disastrous if post-war planning resulted merely in a tidier expansion of the existing industrial aggregations. What is really required is, first, the encouragement of industry into

dustrial areas which are menaced with post-war unemployment, and when this need has been met, the dispersal of industry and populations into communities ten or fifteen miles outside existing towns, as contemplated, for example, in the Plymouth plan. The provisions of the Act, as in all legislation dealing with the ownership of land, are complicated and difficult, but the Committee believes it offers a more acceptable solution of the problems incidental to the public acquisition of land than has been proposed in various plans put forward since planning seized the public imagination.

## Universities of Britain and the Future

A SPECIAL number of the *Political Quarterly* devoted to the future of the universities of Britain contains an article by Sir Lawrence Bragg, "Organisation and Finance of Science in Universities". Sir Lawrence urges the importance of further steps to ensure that the fullest use is made of scientific men and potential scientific workers of the highest quality; and he suggests that more care should be taken to see that the highest ability does not 'fall off the educational ladder' before reaching the university, and that young people possessing such qualities should be carefully guided as to the courses they pursue at the university and the careers they take up afterwards. Then he suggests that an attempt should be made to avoid distracting our best university men from their real work by loading upon them too many extraneous duties, and finally he directs attention to the way in which lack of sufficient money for aids to research reduces the efficiency of our best scientific investigators. Dr. C. P. Snow also examines the question of careers, and pleads for a standing Government committee to report at least once a year on trends in employment of graduates; the Appointments Department of the Ministry of Labour should act in close touch with such a standing committee and have as an essential task the diffusion of information to undergraduates; and the university appointments boards should be strengthened in the large universities on the Cambridge scale, and developed on tutorial lines in the smaller universities. Sir Ernest Simon discusses the number of university students, and Mr. G. D. H. Cole's article on "The Social Studies in the Universities" includes a suggestion for group research in place of individual research for the average postgraduate student, which may have potentialities elsewhere also. Bruce Truscot discusses the "University and its Region", indicating possible developments, and Prof. John Macmurray the functions of a university, stressing the importance of the cultural function, in which the universities of Great Britain are most conspicuously lacking.

## Research and Development in Scotland

SOME further notes on "Scientific Research in Scotland" are contributed by Mr. R. H. S. Robertson to *Discovery* of October, to some extent amplifying those in Bulletin No. 3 of the Scottish Reconstruction Committee (see *Nature*, August 12, p. 205). Some reference is made to the research stations already established in Scotland such as the Macaulay Institute, the Rowett Institute and the Fisheries Research Station at Torry, but no fresh evidence is advanced in favour of the formation of a new Scottish research station or branch of the Department of Scientific and Industrial Research. What is required is rather more attention to local conditions and problems and more effective liaison with the research boards and stations of the Department, whether they are located in Scotland or elsewhere. Modification or adaptation of the Portal house may be as important to suit conditions in Devon or Cornwall as to suit those in Scotland. To duplicate the work of the Building Research Station when the first need is a large all-round expansion of research would be both wasteful and inefficient. The national research stations, wherever located, should be strengthened so as to be capable of dealing with the development of national resources, whether they are found in Cornwall or Durham, Glamorgan or Buchan. In regard to the location of industry, Mr. Robertson is on firmer ground, and his paper emphasizes the need for action on the lines of the Barlow Report and as foreshadowed in the White Paper on "Employment Policy".

## Early Medical Books at Glasgow

To illustrate a current series of lectures on "The Evolution of Social Medicine", by Dr. Douglas Guthrie, there have been placed on view in the Hunterian Library of the University of Glasgow some interesting works from the Hunterian and the Ferguson Collections, and from the library of the Royal Faculty of Physicians and Surgeons. Dr. William Hunter, eminent in London as an obstetrician and an anatomist, though not so famous as his younger brother John, bequeathed his library and museum to the University of Glasgow, where it forms a rich mine of learning. Besides his own magnificent atlas, "The Anatomy of the Gravid Uterus" (1774), the books selected from Hunter's library include some of the earliest works on midwifery. Among the medical classics in the exhibition are the first edition of the works of Hippocrates, printed in Greek by Aldus of Venice in 1526, and another Aldine work, Celsus' "De Medicina", the oldest medical document after Hippocrates, of which the 1528 edition is shown, the Florentine edition of 1478 being still stored away for safety. From the Ferguson Collection come two of the finest works of Paracelsus, "Grosse Wundarztney", 1536, and "Paramirum" (1565), next to which may be seen David Laing's copy of one of the rarest of medical books, Michael Scot's "Liber phisionomie" (1477). Herbal literature is represented by "De historia stirpium" (1540), by Leonard Fuchs, Nehemiah Grew's "Anatomy of Plants" (1682), with many beautiful drawings, and the magnificent "Curious Herbal" of Elizabeth Blackwell (1737). Another rare work is "An Account of the Foxglove" (1785), in which William Withering of Birmingham, a friend of Erasmus Darwin, introduced the use of digitalis in heart disease, having learned of its use as a 'folk remedy' from his country patients. Although the valuable University manuscripts have been stored away for safety, it has been possible to show from the Faculty library a volume of letters of advice, or "consilia", written and signed by Herman Boerhaave of Leyden (1668–1738); the earliest minute book of Glasgow Medical Society (1815), and a manuscript diary of the Crimean War, written by George Buchanan, the first professor of clinical surgery at the University of Glasgow. The exhibition, which has been arranged with the co-operation of Dr. W. R. Cunningham, University librarian, and Dr. Snodgrass, librarian of the Royal Faculty of Physicians and Surgeons, will remain open until the end of January.

## Sunspots and Associated Phenomena

WALTER G. BOWERMAN has an article entitled "Sunspots in Review" in *Sky and Telescope* of September, which, although containing nothing new on the subject, provides an excellent summary of research in this particular branch. Much still remains to be done on the effects of sunspots, and in some cases results obtained by different investigators are of a contradictory nature. Thus, while some have discovered that the sun radiates more heat to the earth with increase in the number of sunspots, others have found no such correlation, and additional material is necessary before any definite conclusion can be drawn. H. H. Clayton, writing in *World Weather*, has pointed out that proof of variation in the sun's radiation with sunspot periods is found in the variation of the polar caps of Mars. When the spots are numerous and at the same time a polar cap is turned towards the sun, it lessens in size. He also states that variations in the light reflected by Jupiter have been found to be associated with sunspot periods. Dr. Stetson, in a letter to Mr. Bowerman, states that evidence from ionospheric investigations reveals an output of solar radiation, especially in the extreme ultra-violet, which is 100–150 per cent greater at sunspot maximum than at minimum. Huntington, writing in "Earth and Sun", suggests that the planets have an influence on sunspots—akin to trigger action—the energy derived from them being like pressing a button to start an explosion. Once a little eddy is started, the slight movement so generated may be reinforced by stresses due to rapid cooling of the sun's outer layer, or to the sun's varying rate of rotation at different latitudes. Mr. Bowerman admits that there are many pitfalls for the student of solar-terrestrial relations, and one must avoid too hasty generalizations. In different parts of the world relationships to temperatures, pressure, and precipitation are not always the same. For example, the Nile shows a maximum height near sunspot maximum, whereas rivers in temperate regions, such as the Parana in the Argentine, show the reverse. Great care is necessary before formulating definite conclusions.

## Industrial Electrical Maintenance

IN a paper read in London on December 14 before the Institution of Electrical Engineers, J. C. B. Nicol contends that industrial maintenance should be controlled through an organized system. From an analysis of the functions of a maintenance department, he derives the principles underlying good organization and illustrates some of these by examples. There are probably many types of equipment data records in use, and it is believed they are all fundamentally the same if different in detail. These differences must cause considerable trouble to manufacturers when supplying information to various customers, and if standard cards were agreed, manufacturers could easily supply them with their equipment. Manufacturers often supply maintenance instructions and connexion diagrams with their equipment, as well as lists of spare parts. If all such information were provided on standard-size pages, which could be bound into a strong loose-leaf book, it could then be given to workmen with a good chance of survival.

It would be advantageous if a standard code of practice for the maintenance of industrial electrical apparatus were compiled and issued by the British Standards Institution. Such a code could not make any comprehensive technical recommendations, but it could specify good administrative procedure, which would tend to standardize systems and facilitate the interchange of maintenance engineers. Some standardization on these lines would make the exchange of information between manufacturers and maintenance engineers easier, and would also help installation contractors and consultants to take an interest in maintenance work and its problems.

## Plastics in Electrical Industry

AN article by A. J. Warner (*Elec. Comm.*, 22, No. 1; 1944), in reviewing the physical and electrical properties of plastics, discusses the various types of plastic materials available, paying particular attention to their electrical properties, and also examines their physical limitations, since there is no 'all-purpose' plastic available for the variety of conditions encountered. In all cases, a compromise must be made between the electrical properties and the mechanical limitations inherent in the material. In the summary which is provided, which of necessity is incomplete and rather fragmentary, such data are collected and collated as will facilitate an intelligent selection of materials. It cannot be too strongly emphasized, however, that, in the present state of the plastic art, a mere tabulation of physical and electrical properties will not necessarily enable one to choose the right material for any particular application. There still exists and will always exist the need for the exercise of judgment and the use of the accumulated knowledge of the particular engineer having the problem under consideration.

For the highest degree of electrical performance, where dielectric properties are of paramount importance, the pure hydrocarbons such as polystyrene and polyethylene are the best materials available. Where cheapness, availability, and good overall physical properties are required for low-frequency applications, and where only moderate electrical performance is required, the recent developments in the urea formaldehydes should be considered. For large sheets of various thicknesses for panel mounting strips, etc., and where high electric strength, reasonably low moisture absorption, and reasonable electrical properties are required, Grade *XXXP* laminated plastics are recommended.

## Equilibrium Diagrams of Alloys

THREE more "Annotated Equilibrium Diagrams" have been published by the Institute of Metals. No. 2 deals with the copper-tin system, No. 3 with the copper-zinc alloys and No. 4 with the copper-aluminium. Prepared by Dr. G. V. Raynor, each sheet contains a large-scale diagram in its latest form, some notes upon it, and an extensive bibliography. At the almost nominal price of 6*d*. per sheet, they represent what is probably the best value attainable anywhere in metallurgical literature.

## Mineral Deficiencies in Pastures

TECHNICAL COMMUNICATION No. 15, issued by the Imperial Bureau of Animal Health (Rowett Institute, Aberdeen, 1944. 5*s*.), entitled "Minerals in Pasture, Deficiencies and Excesses in Relation to Animal Health", by Miss F. C. Russell, is a valuable review of this complex subject. The literature surveyed deals with diseases attributed or attributable to

deficiencies of cobalt (bush sickness of New Zealand, pining in the United Kingdom, etc.); of copper (swayback in the United Kingdom and other countries, which is a disease of lambs with paralysis of the limbs, inco-ordination and demyelination of certain tracts of the spinal cord, which J. R. M. Innes (*Vet. Record*, **55**, 369; 1943) has compared with certain rare diseases of man); of both copper and cobalt; and of potassium, sodium chlorine, iodine, phosphorus, calcium or magnesium (grass or lactation tetany). Other sections deal with diseases attributed or attributable to excesses of selenium, molybdenum, nitrate or manganese and with fluorosis and arsenical poisoning. A useful general summary completes the review, and the bibliographies of each section guide the reader to further study. The problems here discussed are difficult and are not for those who require circumscribed investigations which are certain to give results. Miss Russell has performed very well her difficult task of presenting the controversial literature about them, and everyone who is concerned with this kind of work will be grateful to her.

## Mexico's Vital Statistics

DR. RICARDO GRANILLO, head of the Mexican Department of Statistics and Demography, states that his Department is a part of the Secretariat of National Economy (*Bol. Of. San. Panamericana*, **23**, 419; 1944). It collects and publishes statistics, takes a national census, makes special studies, represents the country at international congresses, and has jurisdiction over population, public education, social welfare, industrial economy and vital statistics. The principal functions of the Vital Statistics Office of the Secretariat of Health and Welfare include keeping Federal and State health authorities informed of the general mortality and that from contagious disease and other important causes; reporting on epidemics in areas where there are no practitioners and regular reports of contagious diseases cannot be obtained; the study of the geographical and seasonal distribution of general, infant, endemic and epidemic disease mortality; reporting to the Panamerican Sanitary Bureau and other international offices and neighbouring health authorities on the general health conditions of Mexico; and keeping a record of public health activity throughout the Republic.

## Nizamiah Observatory, Hyderabad

THE director of the Nizamiah Observatory has communicated a paper, "Occultations of Stars and Planets by the Moon observed at the Nizamiah Observatory, Hyderabad, during the Year 1943" (*Mon. Not. Roy. Astro. Soc.*, **104**, 4; 1944), which gives the occultation results for 1943 from January 11 until December 31. Twenty-seven occultations of stars and one of Venus were observed by M. K. Bappu, using the 15-in. visual refractor. M. V. V. Sastry, assisted by S. Aravamudan, carried out the reductions. In the case of two stars, proper motions were applied to the co-ordinates given in the catalogue in computing the mean places for use in the reductions, and positions were taken from the "Nautical Almanac" for the others.

## The Night Sky in January

NEW moon occurs on January 14d. 05h. 06m., U.T., and full moon on January 26d. 06h. 41m. The following conjunctions with the moon take place: Jan. 4d. 20h., Jupiter 4° S.; Jan. 12d. 08h., Mercury 0·2° S.; Jan. 12d. 21h., Mars 2° S.; Jan. 17d. 14h., Venus 4° N.; Jan. 25d. 18h., Saturn 0·5° N. Mercury is in conjunction with Mars on Jan. 26d. 15h., Mercury being 0·4° N. The following occultations of stars brighter than magnitude 6 take place: Jan. 1d. 20h. 56·5m., 8 Leon. (*R*); Jan. 18d. 17h. 52·8m., 33 Pisc. (*D*); Jan. 21d. 17h. 27·5m., $\mu$ Ceti (*D*); Jan. 24d. 2h. 15·2m., *i* Taur. (*D*); Jan. 25d. 2h. 21·7m., + 20° 1105*m* (*D*); Jan. 26d. 18h. 24·0m., 63 Gemi. (*D*). The times refer to the latitude of Greenwich, and *D* and *R* refer to disappearance and reappearance, respectively. Mercury rises 1½ hours before the sun at the beginning, and 36 minutes before the sun at the end, of the month. It is stationary on Jan. 2 and reaches its greatest westerly elongation on Jan. 13. Venus is conspicuous in the evening hours, setting at 19h. 51m., 20h. 29m. and 21h. 08m. at the beginning, middle and end of the month, respectively. Mars rises about three-quarters of an hour before the sun at the beginning of the month and is not well placed for observation. Jupiter, in the constellation of Virgo, is a conspicuous object in the morning hours and rises at 23h. and 21h. at the beginning and end of the month, respectively. Saturn, in the constellation of Gemini, can be seen throughout the night, setting at 6h. 52m. in the middle of the month.

## Announcements

DR. W. A. WATERS, lecturer in chemistry in the University of Durham, has been elected to an official fellowship in organic chemistry at Balliol College, Oxford.

MR. A. W. LADNER retired from his position of principal of the Marconi Company's School of Wireless Communication at the end of the year, after thirty-two years service with the Company, and twenty-four years as superintendent of instruction. Mr. Ladner will continue to act in an advisory capacity. His place as principal of the School has been taken by Mr. N. C. Stamford, who was previously with the Company and has since been on the teaching staff of the Department of Electrical Engineering at the University of Manchester.

AT the annual meeting of the Genetical Society, the following officers were elected: *President*, Dr. C. D. Darlington; *Vice-Presidents*, Prof. T. J. Jenkin, Prof. R. A. Fisher and Mr. M. B. Crane; *Treasurer*, Miss E. R. Saunders; *Secretaries*, Mr. W. J. C. Lawrence, John Innes Horticultural Institution, Merton, S.W.19, and Mr. R. Race, Galton Laboratory Serum Unit, Department of Pathology, Cambridge.

THE following appointments have recently been made in the Colonial Agricultural Service: V. E. Gale, to be agricultural officer, Nigeria; D. H. Laycock, to be agricultural officer, Nyasaland; A. H. Strickland, to be entomologist, Gold Coast; J. W. D. Fisher, senior agricultural officer, Sierra Leone, to be principal agricultural officer, Sierra Leone; R. R. Glanville, principal agricultural officer, Nigeria, to be director of agriculture, Sierra Leone; and R. O. Williams, deputy director of agriculture, Trinidad, to be director of agriculture, Zanzibar.

ERRATUM.—In the article on the "Deciduous Cypress" in *Nature* of December 16, p. 775, for 12 ft. (line 8, col. 2) read 21 ft.

# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.*

## A New Method for Measuring Diffusion Constants of Biologically Active Substances

THE study of diffusion constants of proteins and other materials of high molecular weight has added much to our knowledge of the nature of these substances (Svedberg and Pederssen[1], Polson[2]). These studies were made on materials which were obtained in the pure state. Unfortunately, when dealing with substances comprising several components, the usual optical method of diffusion (Lamm[3]) cannot be applied except with great difficulty. In such cases recourse must be made to analytical methods. The method of Northrop and Anson[4], namely, diffusion through a porous plate, has been of great value, but this method too has its limitations. Bourdillon[5] has proposed a method for the analytical determination of diffusion constants. His method, although theoretically sound, is very difficult to apply, especially when dealing with viruses. (For a criticism of the above-mentioned methods, see Markham, Smith and Lea[6].)

An account is given below of a method which has been found suitable for the measurement of the diffusion constant of horse-sickness virus.

*Theoretical:* From the well-known law of Fick

$$ds = -AD\frac{dc}{dx}\cdot dt,$$

and its solution

$$\frac{dc}{dx} = \frac{C_0}{2\sqrt{\pi Dt}}\,e^{-x^2/4Dt},$$

the following equation has been deduced

$$D = \frac{S^2}{C_0{}^2A^2}\cdot\frac{\pi}{t},$$

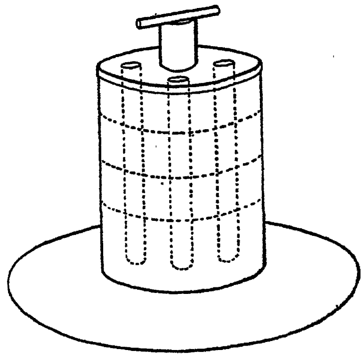
where $S$ is the amount of substance which diffused through a cross-section $A$ cm.² at the original boundary $X = 0$ in $t$ sec. $D$ is the diffusion constant and $C_0$ is the original concentration.

This equation can be applied to all substances which do not sediment appreciably under the influence of gravitation, such as the proteins, enzymes and the small viruses. Its range does not include the larger viruses like vaccinia and psittacosis, as their sedimentation constants are too high.

*Experimental:* To measure the amount of substance which passed a given layer in a diffusion vessel, the apparatus shown in the accompanying diagram was made. Four circular metal sections 1 cm. thick and 4 cm. in diameter were cut and holes 0·5 cm. in diameter drilled through them, except the bottom section, into which the holes extend three-quarters of the thickness of the section. The flat faces of these sections were well ground. They turn on a central bolt which is fixed in a wooden base. In a certain position the holes coincide to form four cylindrical cavities 4 cm. long and 0·5 cm. in diameter. The surfaces between the sections were smeared with a thin layer of wool grease.

The diffusion experiment was run as follows.

The virus solution was placed in the four cavities formed by the bottom two sections, and the cavities in the top two sections filled with suspension medium of a slightly lower density than the fluid in the bottom



cavities. The apparatus was placed in a constant-temperature room and when temperature equilibrium had been reached the top two sections were turned slowly so that the cavities corresponded with those in the lower two sections. In this way sharp interfaces were formed at the contact of the top fluid with the bottom fluid. The apparatus was left in that position for definite periods of time, after which the top fluid was again isolated by rotating the segments. The fluid in the top sections was sucked out with a syringe, the volumes measured and tested for virus content.

The accompanying table gives the results obtained:

| Exp. No. | Time (sec.) | $A$ (cm.²) | $C_0$ in mld.* per c.c. | $S$ in mld.* | $D\times10^7$ cm.²/sec. |
|---|---|---|---|---|---|
| 1 | 151,200 | 0·2 | 160,000 | 2232 | 1·01 |
| 2 | 151,200 | 0·2 | 440,000 | 6480 | 1·01 |
| 3 | 237,600 | 0·2 | 226,000 | 3360 | 0·73 |
| 4 | 331,200 | 0·2 | 200,000 | 2796 | 0·46 |
| | | | | | Av. 0·80 |

* Determined by the Read and Münch method of 50 per cent end-points.

The diameter calculated from the Stokes-Einstein formula for the diffusion of a substance gave the value $d = 53{\cdot}2\,\mu\mu$. This value agrees very well with those determined by other means, namely, ultracentrifugation $45{\cdot}4\,\mu\mu$, and ultrafiltration 40–60 $\mu\mu$ (Polson[7]).

From the sedimentation constant $S = 286 \times 10^{-13}$ Svedbergs, the specific volume $V = 0{\cdot}8$ and the diffusion constant $D = 0{\cdot}8 \times 10^{-7}$ cm.²/sec., the molecular weight is calculated according to the formula of Svedberg[1],

$$M = \frac{RTS}{D(1-V\rho)} = 44{,}500{,}000,$$

where $\rho$ is the density of the suspension medium.

This value for the molecular weight must be considered approximate, as the determination of $D$ depends on the relationship $\frac{(S)^2}{(C_0)^2}$, the determination of which could only be done by biological means.

A more extensive article will be published in the *Onderstepoort Journal.*

ALFRED POLSON.

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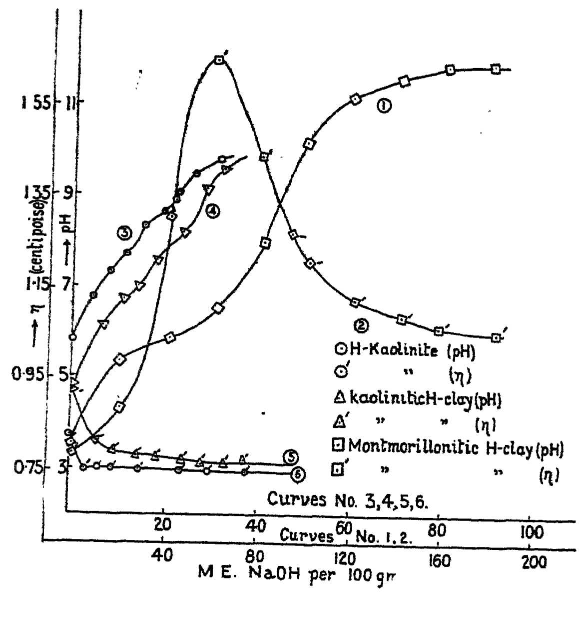
[1] Svedberg and Pederssen, "The Ultracentrifuge" (Oxford University Press, 1940).
[2] Polson, *Koll. Z.*, **87**, 149, and **88**, 51 (1939).
[3] Lamm, *Nova Acta Reg. Soc. Scient. Upsal.*, **4**, 10, No. 6 (1937).
[4] Northrop and Anson, *J. Gen. Physiol.*, **12**, 543 (1928–29).
[5] Bourdillon, *J. Gen. Physiol.*, **24**, 459, and **25**, 263 (1941).
[6] Markham, Smith and Lea, *Parasitology*, **34**, 315 (1942).
[7] Polson, *Onderstepoort J. Vet. Sci. and Animal Ind.*, **16**, 33 (1941).

## ifferentiation of Hydrogen Clays and Identification of their Mineral Constituents by Electrochemical and Viscous Methods

A NUMBER of publications[1,2,3,4] from this Laboratory have dealt with the acid character of hydrogen clays isolated from Indian soils as revealed from a study of their titration curves with bases, buffer indices and base-exchange capacities calculated at the inflexion points of the titration curves. An 'electrochemical method' for differentiating hydrogen clays and identifying clay minerals contained in them has been developed, based on a comparison of their electrochemical properties with those of hydrogen colloids isolated from natural deposits of the clay minerals. Hydrogen kaolinites (prepared by repeatedly leaching entire clay fractions with 0·04 *N* hydrochloric acid and washing free from chlorides) from four different samples of kaolin and a number of hydrogen clays known, from X-ray and dehydration studies carried out by Mr. S. N. Bagchi, to contain kaolinitic minerals, have a dibasic acid character within the range of *p*H 4–11·0[5,6]. The first inflexion usually occurs between *p*H 7·0 and 8·0 and the second between *p*H 8·0 and 9·5 (see diagram). The ratio of the base-exchange capacities at the two inflexion points is nearly 2·0, though the actual value of the base-exchange capacity varies in the case of different hydrogen clays and hydrogen kaolinites from 12·0 m.e. to 23·0 m.e. per 100 gm. at the first inflexion point; and from 20·0 to 45·0 m.e. per 100 gm. at the second inflexion.

Hydrogen clays containing only montmorillonitic minerals as judged from X-ray analysis show only one inflexion between *p*H 7·1 and 8·8 in their titration curve with caustic soda (see graph) and between *p*H 5·2 and 7·5 when titrated with barium hydroxide and calcium hydroxide[7,8]. The base-exchange capacity calculated at this inflexion point varies from 55 m.e. to 100 m.e. per 100 gm. for entire hydrogen clay fractions.

Another criterion for differentiating kaolinitic clays from those containing montmorillonitic minerals has been found and is based on the effect of addition of




caustic soda on the viscosity of aqueous suspensions of the hydrogen clays. On the gradual addition of the alkali to hydrosols of hydrogen bentonites[9] and montmorillonitic hydrogen clays[10], their viscosity increases and passes through a maximum value at a point corresponding to about 75 per cent neutralization of the amount of the acid given by the inflexion point of the titration curve. Apart from a slight initial decrease, the alkali has no marked effect on the viscosity of hydrogen kaolinite and hydrogen clays containing only kaolinitic minerals within the range *p*H 4–11. The viscosity of one of the hydrogen kaolinites, *D*, slightly increased on the addition of the alkali, after which the viscosity remained practically constant. X-ray analysis showed that it contains montmorillonite in addition to kaolinitic minerals. Six subfractions having average equivalent spherical diameters 1·4, 0·70, 0·50, 0·32, 0·21 and less than 0·18 microns were isolated by the graded centrifugalization of *D*. A concentration of montmorillonite in the finer subfractions was indicated by the chemical compositions; nature of potentiometric titration curves with caustic soda; base-exchange capacities; and the effect of the alkali on the viscosity.

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[1] Mukherjee, Mitra and Mukherjee, *Trans. Nat. Inst. Sci. India*, **1**, No. 10, 227 (1937).
[2] Mitra, *Ind. J. Agric. Sci.*, **10**, 317 (1940).
[3] Mukherjee and Mitra, *Ind. J. Agric. Sci.*, **12**, 433 (1942).
[4] Mitra, *Bull. Ind. Soc. Soil Sci.*, No. 4, 41 (1942).
[5] Mukherjee, Mitra and Mitra, *J. Phys. Chem.*, **47**, 543 (1943).
[6] Mitra and Biswas, *Proc. 31st Ind. Sci. Cong.*, **3**, 152 (1944).
[7] Mitra, Bagchi and Ray, *J. Phys. Chem.*, **47**, 549 (1943).
[8] Mitra, Bagchi, Ray and Mukherjee, S., *Ind. J. Agric. Sci.*, **13**, 18 (1943).
[9] Mukherjee, Sen Gupta and Indra, *J. Phys. Chem.*, **47**, 553 (1943).
[10] Mitra, Indra and Ray, *Proc. 31st Ind. Sci. Cong.*, **3**, 152 (1944).

## Antioxidants and Prevention of Rancidity in certain Pacific Coast Fish

DURING recent years it has been established that herring muscle[1] and pork muscle[2] possess a lipoxidase enzyme (or enzymes) which is capable of accelerating post-mortem oxidation of the tissue fats. This enzyme catalyses the formation of peroxides from the unsaturated fatty acids present, and consequently facilitates the development of rancid odours and flavours in the flesh. The enzyme concerned is sensitive to heat, will function actively at temperatures well below 0° C. and its action is markedly accelerated by pure sodium chloride. This last-named property has been used to explain the fact that certain cured fish and meats are particularly liable to become rancid during storage.

On the north Pacific coast of America the flesh of many of the most valuable food fishes is rich in fat, and consequently cold storage of such fish under conditions which will prevent the formation of rancid fat has always presented a problem. The practice of lightly brining fillets prior to freezing them in order to prevent drip when they are thawed is by no means uncommon on this continent[3], and this procedure is well known to lead to the premature development of a 'salt fish' flavour and rancidity in treated fillets.

TABLE 1.

| Expt. | Treatment | Peroxide value after storage for 64 days at average temperature of − 3° C. |
|---|---|---|
| 1 | Minced flesh untreated | 4·95 |
| | Minced flesh with 1 per cent sodium chloride incorporated | 20·3 |
| | Minced flesh with 0·02 per cent ethyl gallate incorporated | 0·1 |
| | Minced flesh with 1 per cent sodium choride plus 0·02 per cent ethyl gallate incorporated | 0·2 |
| 1 | Fillets untreated | 13·3 |
| | Fillets dipped in 20 per cent sodium chloride | 33·6 |
| | Fillets dipped in 20 per cent sodium chloride containing 0·5 per cent ethyl gallate | 0·3 |
| | Fillets dipped in 20 per cent sodium chloride followed by 0·25 per cent ethyl gallate | 1·35 |
| | Fillets dipped in 0·25 per cent ethyl gallate followed by 20 per cent sodium chloride | 6·15 |
| | Fillets dipped in 20 per cent sodium chloride containing 0·25 per cent ethyl gallate | 0·3 |
| | | After storage for 46 days at average temperature of − 5° C. |
| 2 | Fillets untreated | 17·6 |
| | Fillets dipped in 1 per cent ethyl gallate | 2·2* |
| | Fillets dipped in 0·5 per cent ethyl gallate | 2·0* |
| | Fillets dipped in 0·1 per cent ethyl gallate | 6·5 |
| | Fillets dipped in 1 per cent sodium gallate | 13·0 |
| | Fillets dipped in 0·5 per cent sodium gallate | 17·6 |
| | Fillets dipped in 0·1 per cent sodium gallate | 17·0 |

* In this experiment, bait herring which had been frozen for some months in blocks were used, the initial peroxide value of the fat being 2·0, while in the first experiment strictly fresh herring in which the peroxide value was zero were used.

In this connexion, recent work[4] has shown that fillets of certain species of Pacific salmon readily become rancid when they are stored at temperatures which are commonly employed commercially (−12° and −20° C.), and that this susceptibility is significantly increased when the fillets are lightly brined prior to freezing. The practice of 'glazing' whole fish with a thin layer of ice undoubtedly retards the development of rancid fats. Storing fish at low temperatures (−28° to −30° C.) has also been found to exert a desirable effect[5], but such temperatures are seldom realized commercially.

In view of these facts, experiments were commenced in order to determine the possible value of antioxidants as a means of inhibiting the development of a rancid condition in the flesh of local fatty fish. For convenient practical application an antioxidant which is sufficiently soluble in water so that it can be added to a liquid in which the fish are immersed, and yet which is highly soluble in fat so that it will be readily absorbed by the flesh, was sought. It was also realized that such an antioxidant would have to be fairly cheap and relatively non-toxic. Recently ethyl gallate, 1 : 5-dihydroxynaphthalene and guiacum resin have been used experimentally to hinder the development of oxidative rancidity in certain foods[6,7]. Of these substances, ethyl gallate was selected for the present work since it possesses the following properties. It is fairly soluble in both water and in fats, has little or no adverse effect on the flavour of foods in concentrations which strongly inhibit fat oxidation, is not very expensive and is comparatively non-toxic for mice[8]. In addition, it is known that gallic acid itself is practically non-toxic and that about one third of the aqueous extracts of tea leaves consists of tannins which are rich in gallic acid. Some experiments were also made using sodium gallate, which would in practice be somewhat cheaper than the ester.

In the experiments described below, fish fillets were immersed from one minute in the solutions, a draining period of one minute being permitted between two successive dips. Sodium gallate solutions were prepared by bringing solutions of gallic acid to *p*H 6 with sodium hydroxide. Treated fillets were wrapped in moisture-proof 'Cellophane' paper during storage. Peroxide values on the extracted fat were determined by Lea's method[9], the results being reported as ml. of 0·002 *N* sodium thiosulphate per gm. of fat. The results of two experiments with herring are given in Table 1.

It will be seen that in the case of minced flesh the addition of 1 per cent sodium chloride greatly increased the peroxide value obtained on storage. The incorporation of 0·02 per cent ethyl gallate in the flesh strongly suppressed peroxide formation even in flesh treated with sodium chloride. Immersing fillets in sodium chloride brine greatly increased the peroxide value of the stored fish, while addition of 0·5 per cent ethyl gallate to the brine strongly retarded peroxide formation. Results obtained using 0·25 per cent ethyl gallate solutions showed that lower peroxide values resulted when fillets were treated with ethyl gallate after brining than when treated prior to or during the brining procedure. Sodium gallate solutions were not nearly so effective as ethyl gallate solutions, presumably due to the low solubility of the sodium salt in fat.

The results of an experiment in which white spring salmon fillets were treated with various solutions and then stored at 0° C. are given in Table 2. The results at this temperature were naturally complicated by the fact that considerable bacterial growth occurred, and it is known that reducing systems of bacteria normally inhibit peroxide formation[9]. It will be seen that so far as accumulation of peroxides was concerned, the use of sodium chloride temporarily accelerated their formation, but that after fifteen days, when bacterial decomposition was very marked, similar values were obtained in both the brined and untreated fillets. At the natural *p*H of the fish flesh (about 6·2), sodium nitrite, which has marked bacteriostatic properties[10], exerted a slight antioxidant effect. For the short storage period

TABLE 2.

| Treatment | Peroxide value after | | Bacteria in millions per gm. by direct count after | |
|---|---|---|---|---|
| | 6 days | 15 days | 6 days | 15 days |
| Untreated | 0·4 | 0·95 | 125 | 380 |
| Dipped in 0·5 per cent ethyl gallate | 0 | 0 | 1·7 | 410 |
| Dipped in 0·5 per cent sodium gallate | 0 | 0 | 3·8 | 980 |
| Dipped in 0·5 per cent sodium nitrite | 0 | 0·15 | 0·3 | 2 |
| Dipped in 20 per cent sodium chloride | 1·3 | 0·95 | 6·2 | 540 |
| Dipped in 20 per cent sodium chloride containing 0·5 per cent ethyl gallate | 0 | 0 | 0·1 | 210 |
| Dipped in 20 per cent sodium chloride containing 0·5 per cent sodium gallate | 0 | 0·1 | 1·7 | 640 |

studied, ethyl gallate and sodium gallate proved effective antioxidants. Sodium nitrite strongly retarded bacterial decomposition. Ethyl gallate, and to a somewhat slighter extent sodium gallate, inhibited bacterial growth. In this connexion it must be noted that experiments with minced salmon flesh have shown that the incorporation of 0·02 per cent ethyl gallate retards both bacterial growth and the onset of oxidative rancidity. The bleaching of the astacin pigments of salmon during cold storage is largely prevented by ethyl gallate.

It is intended to publish the detailed results of these experiments in the *Journal of the Fisheries Research Board of Canada*.

H. L. A. TARR.

Pacific Fisheries Experimental Station,
Vancouver, B.C. Sept. 29.

[1] Banks, A., *J. Soc. Chem. Ind.*, **56**, 13 T (1937).
[2] Lea, C. H. *J. Soc. Chem. Ind.*, **56**, 376 T (1937).
[3] Tarr, H. L. A., *J. Fish. Res. Bd. Can.*, **5**, 411 (1942).
[4] Stansby, M. E., and Harrison, R. W., *U.S. Fish and Wildlife Service Spec. Sci. Rep.*, No. 15 (1942).
[5] Banks, A., *J. Soc. Chem. Ind.*, **57**, 124 T (1938).
[6] Lea, C. H., *J. Soc. Chem. Ind.*, **63**, 55 (1944).
[7] Lea, C. H., *J. Soc. Chem. Ind.*, **63**, 107 (1944).
[8] Hilditch, T. P., *Chem. and Ind.*, No. 8, 67 (1944).
[9] Lea, C. H., "Rancidity in Edible Fats", *D.S.I.R. Food Invest. Spec. Rep.*, No. 46 (1938).
[10] Tarr, H. L. A., *Nature*, **147**, 417 (1941).

## Apparent Respiration of Wheat Grains and its Relation to a Fungal Mycelium beneath the Epidermis

THE experimental evidence summarized below has led us to the conclusion that the carbon dioxide produced by stored wheat, apparently by respiration of the grain itself, is in fact produced almost entirely by micro-organisms growing in the pericarp ('bran') of the grains.

Respiration measurements made on wheat stored at 25° C. show a progressive increase in the rate of carbon dioxide output over a period of several months. The increased respiration-rate persists if the wheat is removed to a lower temperature, and may be many times greater than that of wheat which has been stored for the same period at the lower temperature. The effect is greatest in wheat having a water content higher than 15 per cent (wet-weight basis), but we have observed progressive increase in respiration-rate of wheat drier than this when stored at 25° C. for periods of six months or more. This is confirmed by some of the results of Robertson, Lute and Gardner[1].

Progressive increase in respiration-rate suggests progressive development of actively respiring tissue, but it has not been possible to detect any corresponding increase in the size or differentiation of the wheat embryo.

Wheat grains from which the embryo has been removed by the attack of larvæ of a moth, *Ephestia elutella* Hb., have a respiration-rate nearly as high as that of undamaged grains hand-picked from the same sample. Since the embryo is the only part of the wheat grain which would be expected to be actively respiring, this suggests that the chief source of respiratory carbon dioxide is external to the seed proper and is much greater than that of the embryo.

Leach[2] has recently reported respiration measurements on wheat grains the embryos of which were removed by drilling, and has similarly shown that there is little, if any, fall in respiration-rate on removal of what is presumably the most active tissue of the fruit. From this Leach has come to a conclusion similar to our own, namely, that the respiration of wheat which is too dry to germinate is due almost entirely to micro-organisms that infect it. Since wound reactions and other effects may follow removal of the embryo, we do not consider this evidence, by itself, a sufficiently firm basis for the conclusion.

The pericarp of wheat grains is largely removed by abrasion if a sample of grain is shaken with coarse carborundum powder in a sealed glass bottle for about 48 hours. We have found that this process reduces the rate of carbon dioxide output to about 5 per cent of its original value. Such wheat is not injured or dead, for it will germinate as rapidly and completely as before treatment provided that the abrasion process has not been carried too far.

That the lowering of respiration-rate is not due to a toxic effect of carborundum powder is shown by the fact that a similar effect may be obtained by the use of crushed flint or glass powder. Also, if carborundum is mixed with whole wheat the respiration-rate is unaffected.

This experiment shows that the carbon dioxide produced by wheat originates largely in the pericarp; yet microscopical examination of sections of this structure shows few, if any, cells which appear to be actively developing or even living.

The epidermis of the pericarp may usually be stripped from a grain of wheat, sometimes almost entire, after soaking for a few minutes in water. Staining with aniline blue will usually reveal a number of fungal hyphæ, and in some samples an extensive mycelium, on the *inner* surface of the epidermis. Unless grains are obviously mouldy, no hyphæ can be found on the *outer* surface of the epidermis. It seems likely that this fungal mycelium is part, at least, of the micro-flora the existence of which is suggested by the experiments described. We have demonstrated the existence of a similar flora under the epidermis of maize, particularly over the embryo and basal parts of the seed.

The mycelium is abundant in many samples of English wheat immediately after harvest, when the water content may range from 15 to 25 per cent or even higher, and is detectable, though in rather small quantity, in Canadian and other wheats with a water content in the region of 12 per cent. The abundance of mycelium may be a measure of the dampness of the grain during the period immediately before harvest.

It is important to note that we have demonstrated a mycelium which is absent from the surface of the grain. Previous reports of fungi associated with wheat, and measurements of their amount, have been based on the numbers of colonies obtained by shaking grain with sterile water. Such investigations probably reveal only superficial spores which, until they have germinated, can make no measurable contribution to the apparent metabolism of the wheat grain. Such estimates of fungal and bacterial population are irrelevant to the probable life of grain or other seeds in storage, unless the humidity becomes high enough to permit spores to germinate rapidly.

Since the mycelium is vegetative, we have been unable to identify any of the organisms which compose it or even to verify that they are fungi, and we have not so far been successful in isolating them free from contamination by the spores which are

invariably present on the outer surface of the epidermis. We are, however, attempting to grow wheat to maturity under aseptic conditions from sterilized seed in order to obtain a small crop of grain free from contamination for comparison with normal wheat. When data for this comparison are available we will publish our detailed results elsewhere.

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Department of Scientific and Industrial Research,
Pest Infestation Laboratory,
Slough, Bucks. Nov. 3.

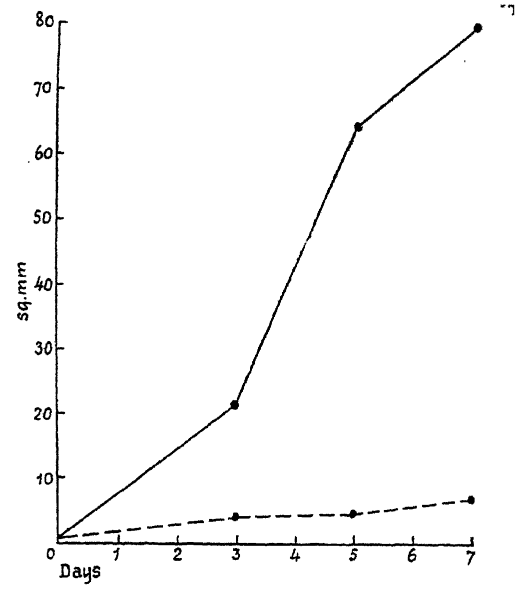
[1] Robertson, D. W., Lute, A. M., and Gardner, R., *J. Agric. Res.*, **59**, 281 (1939).
[2] Leach, W., *Canad. J. Res.*, **22** C, 150 (1944).

## Concurrence of Growth-promoting and Growth-inhibiting Factors in Extracts of Adult Rat Tissues

IN previous papers[1] from this laboratory it was shown that saline extracts of adult tissues and organs have a marked growth promoting effect on cell colonies *in vitro*. Under given experimental conditions, the growth-promoting activity of certain adult tissue extracts is several times that of embryonic tissue extracts of the same concentration. Although most tissues and organs of the adult organism display the growth-promoting power, the activity of the extracts varies from organ to organ. It is particularly high in heart, brain and smooth muscle, and low in kidney, bone marrow and liver.

Organs of almost all species tested (dog, sheep, cow, rabbit) were found to yield active extracts[2]. Extracts of rat organs, on the other hand, are exceptional in their behaviour with regard to cell-growth activation[3]. Of rat organs and tissues, only brain and embryo tissue displayed marked growth-promoting power; extracts of all other rat organs have either no growth-promoting property or inhibit the growth of cells *in vitro*. The unequal growth-promoting power of extracts of different origin could be accounted for by either of the following assumptions: (1) that the growth-promoting principles are present in amounts varying from organ to organ and species to species; (2) that the difference in activity is due to the simultaneous presence in varying concentration of growth-inhibiting factors, which counteract cell proliferation.

Our experiments have shown that the absence of growth-promoting ability in extracts of most organs of adult rats can be explained in accordance with the second assumption. In the investigations reported below, the procedure previously used[4] by us for the partial purification of active principle from growth-promoting adult tissue extract was used. The experiments were performed with extracts of rat heart muscle, which have either no stimulating action or even inhibit cell growth. Minced heart muscle was extracted with four volumes of normal saline and this extract was precipitated with four volumes of alcohol. The precipitate obtained was then treated in a Soxhlet apparatus with acetone or petroleum-ether. The extracted material after drying was taken up in 'Tyrode'. Solutions thus obtained were added to standardized cultures of chicken fibroblasts in Carrel flasks. The growth of the cell colonies in medium containing this solution as supernatant fluid phase was compared with the growth of controls (sister




EXPERIMENT 11245 A. GROWTH OF CHICKEN FIBROBLASTS (FULL CURVE) IN MEDIUM CONTAINING SOLUTION OF ALCOHOL PRECIPITATE OF RAT HEART EXTRACT, TREATED WITH PETROLEUM-ETHER; AND GROWTH IN PROTECTIVE MEDIUM (BROKEN CURVE).

halves) growing in protective medium composed of plasma diluted with 'Tyrode' 1 : 2 and covered with 'Tyrode' solution. The growth of cultures was recorded according to the method of Ebeling.

It could be shown that originally inactive rat tissue extracts are rendered active by the above treatment. Even alcohol precipitates of the extracts had slight growth-promoting activity. Subsequent treatment with petroleum-ether or acetone proved to be decisive. Petroleum-ether and acetone convert material originally inert and only slightly active after alcohol treatment into definitely active preparations.

The curves of the accompanying graph show the growth of a culture stimulated with a petroleum-ether-treated alcohol precipitate of rat heart extract compared with that of a control. These curves illustrate the optimal activation obtained, the average stimulation amounting to 450 per cent.

It may be concluded that the inability of rat tissue extracts to stimulate the growth of cells *in vitro* is due to the fact that in rat tissues (heart muscle) the growth-promoting substance is masked by the predominance of growth-inhibiting factors. The latter are probably of a lipoid nature.

Details of our experiments are being published elsewhere.

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[1] Doljanski, L., and Hoffman, R. S., *C.R. Soc. Biol.*, **130**, 1264 (1939). Hoffman, R. S., and Doljanski, L., *Growth*, **3**, 61 (1939). Hoffman, R. S., Tenenbaum, E., and Doljanski, L., *Nature*, **143**, 764 (1939). Hoffman, R. S., Tenenbaum, E., and Doljanski, L., *Growth*, **4**, 207 (1940).
[2] Doljanski, L., Hoffman, R. S., and Tenenbaum, E., *Nature*, **150**, 23 (1942).
[3] Hoffman, R. S., *Growth*, **4**, 361 (1940).
[4] Werner, H., and Doljanski, L., *Nature*, **150**, 660 (1942).

## Production of 'Endomitosis' in Bean Roots and its Bearing on the Genesis of Tumours

Biesele, Poyner and Painter have shown[1] that diplochromosomes and higher polytenes are often to be found in tumours and that these large chromosomes are the result of endomitosis. Biesele and Cowdry[2] also found these abnormalities in the epidermis of mice painted with methylcholanthrene, as early as two days after painting.

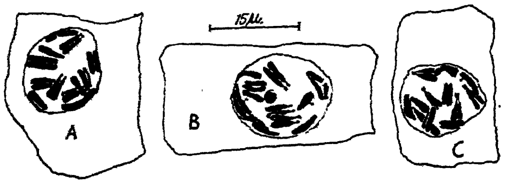
Recently, using bean roots, endomitosis was found by chance in roots allowed to become partially dry. Following up this observation, it was found that exposure to a colloidal suspension of benzpyrene and to hypertonic sugar solution also gave rise to this change.

I use the term 'endomitosis' because it was used by Biesele and others to describe[1] their findings. They found fully condensed chromosomes in nuclei having intact walls. The figure below shows similar abnormalities in treated bean roots.

The details of treatment were as follows. For partial drying, use a root about 20 cm. long—to obtain this length it is necessary to remove all lateral roots—pass it down glass tubing so that only 2 cm. are immersed in distilled water; leave it thus for 12 hours and then examine histologically. For benzpyrene treatment, substitute for the distilled water a colloidal suspension of 0·05 per cent in distilled water (good suspensions cannot be made in the presence of salts); under these conditions, the action of benzpyrene and of partial drying are combined, and abundant endomitoses are produced. Benzpyrene treatment without partial drying is obtained by filling the tubing to the top with colloid, but longer exposures of 24–48 hours are required. The effect is not obtained with short roots and before leaves have formed; it seems that an abundant volume of water must be absorbed—and this does not occur with short roots—for a sufficient amount of benzpyrene to enter. The suspended particles do not appear to enter, but only benzpyrene in solution. Occasional endomitoses were obtained by placing the roots in 8–10 per cent dextrose.

It is to be noted that two of the agents are potent to produce increased viscosity of the cytoplasm; as regards benzpyrene, information is wanting. Further, Guyer and Claus, using the ultracentrifuge, have shown[3] that tumour cells present great stiffening of the cytoplasm in comparison to cells of normal tissues, and that this applies not only to experimentally produced hepatomas, but also to liver cells in pre-cancerous stages.

It is likely, therefore, that endomitosis, polytene, polyploid and polynuclear cells of tumours are secondary to an increased stiffness of the cytoplasm and no more than signs of such a change.




THE FIGURE SHOWS THREE CELLS FROM ROOT TIP OF BEANS, STAINED WITH IODINE GENTIAN VIOLET: *A*, TREATED FOR 20 HOURS WITH BENZPYRENE; *B*, FOR 12 HOURS BY PARTIAL DRYING; AND *C*, WITH 8 PER CENT DEXTROSE FOR 24 HOURS. THE CHROMOSOMES ($2n = 12$) ARE ABNORMALLY CONDENSED AND THE CHROMATIDS CLOSELY APPLIED AS IN LATE METAPHASE. AT THE SAME TIME A FINE NUCLEAR WALL IS PRESENT. IN *B* THE NUCLEOLUS HAS NOT BEEN ENTIRELY ABSORBED. IN *A* AND *B* THE CENTROMERES APPEAR TO HAVE DIVIDED AND IN *C* TO BE UNDIVIDED. IN *B* AND *C*, LATERAL TRABANTS ARE PRESENT.

Increased viscosity of the cytoplasm was observed[4] as a common reaction of ciliates to a wide range of tumour-producing agents, and led to races of multiple organisms.

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Nov. 2.

[1] Biesele, J. J., Poyner, H., and Painter, T. S., Univ. Texas Publ. No. 4243 (1942).

[2] Biesele, J. J., and Cowdry, E. V., *J. Nat. Cancer Inst.*, **4**, 373 (1944).

[3] Guyer, M. F., and Claus, P. E., *Proc. Soc. Exp. Biol. and Med.*, **35**, 568 (1936); *Anat. Rec.*, **73**, 17 (1937); *Canc. Res.*, **2**, 16 (1941).

[4] Mottram, J. C., "The Problem of Tumours" (London: Lewis and Co., Ltd., 1942).

## Effect of some Pure Substances on Plant Growth

INCREASING concentration of heteroauxin in lanolin – water paste causes progressive inhibition of the growth of hypocotyls of dark-grown *Helianthus* seedlings. At moderate concentrations definite swellings are produced. These effects can be considered as being the result of a progressive disorientation of the cytoskeleton with corresponding loss of cell polarity. A higher degree of disorganization would naturally lead to autolysis. In the presence of the sodium salts of alizarin and quinizarin sulphonic acids, the above effects can be so modified that it requires a higher concentration of heteroauxin to produce an effect similar to that produced with lower concentrations of heteroauxin alone. Tests with the alizarin sulphonate indicate that in aqueous solution it does not destroy heteroauxin to any great extent when this is estimated colorimetrically.

The growth of oat roots can be inhibited by *o*-, *m*- and *p*-phenylene-diamine, benzidene, benzoquinone and other substances, these simultaneously staining the cell wall. In an extremely dilute solution of phenanthraquinone, roots gave a growth value only 16 per cent of those grown in tap water. Gallic and di-gallic acids in 0·01 per cent solution gave values of about 50 per cent. These substances have the property of reacting with proteins and would act as molecular cross-linkages[1] between the proteins of the embryonic cells of the root tip, thus preventing development of the normal dynamic cytoskeleton.

On a hypothesis that auxin by some means disengages certain bonds of attachment between the proteins or components of the cytoskeleton, the various effects of auxins become more understandable. Normal extension of a cell would result from the action of auxins on the three-dimensional lattices[2,3] of the cell wall and cytoskeleton. An artificial cytoskeleton such as would be formed in the root tips with some protein reactants would be stable and non-reactive to auxins. It is possible that alizarin and quinizarin sulphonic acids act more selectively on the hypocotyl cells.

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Nov. 8.

[1] Powell, A. K., *Nature*, **153**, 345 (1944).

[2] Frey-Wyssling, A., *Science Progress*, **34**, 249 (1939).

[3] Needham, J., "Biochemistry and Morphogenesis" (Cambridge, 1942).

## Formation of Creatinine in the Animal Body

H. Borsook and J. W. Dubnoff[1] have discovered that phosphocreatine is changed into creatinine in water solution at 38° and $pH$ 7, by splitting off phosphate, and they consider that this spontaneous reaction is the way in which creatinine is formed in the animal body. In connexion with this important discovery, I want to direct attention to similar results which I published in 1940, and which for obvious reasons did not reach any abstracting journal published abroad.

I found[2] that in minced muscle (38° C.) in the presence of fluoride, iodacetate or hydrogen cyanide, the formation of creatinine was greatly accelerated, and I tried to explain that fact by a non-hydrolytic dephosphorylation of phosphocreatine. The idea that creatinine is formed not by splitting off water from creatine but by the splitting of phosphate from phosphocreatine is now made fully evident by Borsook and Dubnoff's experimental work.

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[1] Borsook and Dubnoff, "Annual Review of Biochemistry", **12**, 187 (1943).

[2] Rosengart, V., *Bull. Med. Coll., Dnepropetrovsk, U.S.S.R.*, **2**, 87 (1940) (in Russian).

## Prolongation of the Effect of Narcotics by Combination with Mucic Acid

A SEARCH for improved methods of prolonging the effect of the injection of morphine and other narcotics resulted in the observation that, for a given dose of morphine, the period of narcosis can be considerably extended if the base is administered in the form of mucate instead of the usual salts such as tartrate, sulphate, etc. This prolongation of effect is also obtained with the mucic acid compounds of other physiologically active bases such as adrenaline and ergometrine.

Some of these compounds are now undergoing systematic pharmacological and clinical test, the results of which will be published elsewhere in due course. In the meantime, other compounds of mucic acid, its homologues, analogues and their derivatives are being prepared and examined to ascertain if this particular property is exhibited by them all to a greater or lesser extent.

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## Inheritance of the 'Bolter' Condition in the Potato

'BOLTERS' occur[1,2] in many potato varieties and are distinguished from the normal plants of the variety by the following characteristics: the haulms are more vigorous, taller and with longer internodes, the tubers are coarser and the crop heavier at maturity, maturity is much later, and flowering is much freer. The 'bolter' condition is perpetuated by the tubers, and Davidson[1] states that bolters obtained in 1917 from the variety Snowdrop have always produced bolters.

This group of characters by which the 'bolter' differs from the normal plant of the variety might be due to the pleiotropic effects of a single gene, but a more attractive hypothesis is that it is due to the loss or gain of a whole chromosome. Root-tip counts of 'bolter' plants of the varieties Gladstone and Ulster Chieftain showed, however, that the chromosome number was $2n = 48$ and was identical with that of the normal plants of the varieties (these counts were made by Mr. N. W. Simmonds and checked by one of us, H. W. H.).

'Bolters' also differ from normal plants in having 'wilder' underground parts, that is, the stolons are more numerous, longer and more persistent. The root system also appears to be more strongly developed. These differences have been utilized in comparing the two crosses, Gladstone female × Flourball and Gladstone 'bolter' female × Flourball. A third family from the cross U.S.D.A. seedling 41956 female × Flourball is also available for comparison.

The crosses were made in 1942 (the 'bolter' Gladstone having been collected in 1941 from a field of Gladstone in Northern Ireland) and the seedlings were raised in pots in 1943 in an insect-proof glasshouse. In 1944 two tubers from each seedling were planted out in the field for scoring and the results are shown in the accompanying table.

| Family | Cross | No. of distinct seedlings | Percentage of plants with underground parts: cultivated | somewhat wild | wild | very wild |
|---|---|---|---|---|---|---|
| 50/43 | Gladstone 'bolter' × Flourball | 25 | 20 | 44 | 24 | 12 |
| 49/43 | Gladstone × Flourball | 52 | 58 | 25 | 17 | 0 |
| 47/43 | U.S.D.A. 41956 × Flourball | 133 | 62 | 20 | 17 | 1½ |

Families 49/43 and 47/43 have similar percentages of plants in the four groupings of underground parts, but family 50/43 from the 'bolter' Gladstone cross differs in having many fewer plants with the cultivated type and more plants with the somewhat wild, wild and very wild underground parts. Thus there seems no doubt that 'bolter' Gladstone differs in being genetically 'wilder' than normal Gladstone. On August 10 families 49/43 and 50/43 were scored for flowering; 38 per cent of the plants in family 49/43 had flowered as compared with 57 per cent in family 50/43.

Mr. John Clarke (the well-known Northern Ireland potato breeder) of Broughgammon, Ballycastle, Co. Antrim, has told us in conversation this year that he obtained similar results when comparing the cross Epicure 'bolter' × Herald with the cross Epicure × Herald. More than 50 per cent of the plants in the family from the 'bolter' cross were 'wild' types as compared with a small percentage from the cross Epicure × Herald.

Since a series of intermediates between the normal and bolter type occur and since it is known that maturity, flowering and stolon development are influenced strongly by the length of day, it is possible that the 'bolter' condition arises through the mutation of the gene or genes governing the photoperiodic reaction.

G. P. CARSON.
H. W. HOWARD.

Plant Breeding Institute,
School of Agriculture,
Cambridge. Oct. 19.

[1] "Potato Growing for Seed Purposes" (Dublin, 1937).

[2] "The Maintenance of Pure and Vigorous Stocks of Varieties of the Potato", Revised ed. (Edinburgh, 1944).

## Body-Weight as Determinator of Physical Efficiency

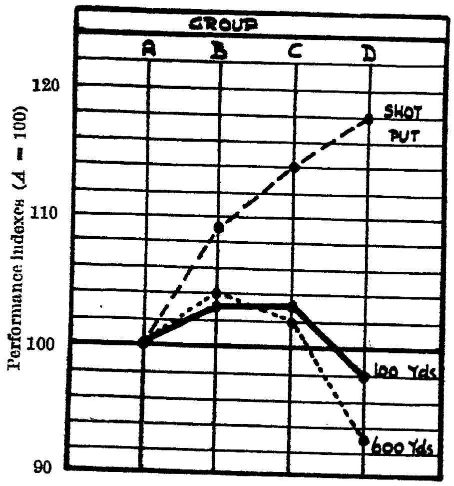
IN view of the nutritional, educational and other implications of physical development, it is desirable to arrive at an objective evaluation of anthropometric measurements. Among the determinators of muscular efficiency which a study of physical fitness of school children in South Africa has revealed[1], body weight has been found to be of significance. We apply three performance tests intended to yield information with regard to neuro-muscular skill and speed (100 yards running), circulatory and respiratory endurance (600 yards running) and muscular strength (putting the 12 lb. shot). As the accompanying table and graph indicate, a specific determination of performance standards through body-weight is noticeable. In the 100-yard race, underweight and overweight are about equally disadvantageous. In the 600-yard race overweight is more disadvantageous than underweight, while in putting the shot only underweight is disadvantageous. The medium body-weight levels are associated with the best all-round physical efficiency.

The tests were conducted with 1,514 boys of between 6 and 17 years of age. Baldwin and Wood's age-weight tables were used as standards. The four weight sub-groups ($A-D$) were calculated according to Bogert's[2] recommendation.

A detailed account of our findings, with special reference to nutritional problems, will appear in *Manpower* (Pretoria), the official organ of the National Advisory Council for Physical Education.

| Item | Unit | Group* | | | | Mean differences | Remarks on differences |
|---|---|---|---|---|---|---|---|
| | | *A* | *B* | *C* | *D* | | |
| NUMBER OF BOYS | | 351 | 492 | 544 | 127 | | |
| *100 Yd. Running:* | | | | | | | |
| Mean | Sec. | 16·16 | 15·62 | 15·63 | 16·54 | $A-B: +\ 0·54$ | Significant |
| S.D. | ,, | 2·205 | 2·252 | 2·175 | 2·235 | $B-C: -\ 0·01$ | Not significant |
| S.E.M. | ,, | 0·118 | 0·102 | 0·093 | 0·203 | $C-D: -\ 0·91$ | Significant |
| Mean Index† | $A = 100$ | 100 | 103 | 103 | 98 | $A-D: -\ 0·38$ | Not significant |
| *600 Yd. Running:* | | | | | | | |
| Mean | Sec. | 141·1 | 136·3 | 138·0 | 151·0 | $A-B: +\ 4·8$ | Significant |
| S.D. | ,, | 18·15 | 20·70 | 20·10 | 20·85 | $B-C: -\ 1·7$ | Not significant |
| S.E.M. | ,, | 0·969 | 0·933 | 0·862 | 1·890 | $C-D: -\ 13·0$ | Significant |
| Mean Index† | $A = 100$ | 100 | 104 | 102 | 93 | $A-D: -\ 9·9$ | Significant |
| *Shot Put (12 lb.)* | | | | | | | |
| Mean | Inches | 142·9 | 156·4 | 162·7 | 168·2 | $B-A: +\ 13·5$ | Significant |
| S.D. | ,, | 67·56 | 77·82 | 84·66 | 82·32 | $C-B: +\ 6·3$ | Not significant |
| S.E.M. | ,, | 3·605 | 3·508 | 3·630 | 7·463 | $D-C: +\ 5·5$ | Not significant |
| Mean Index | $A = 100$ | 100 | 109 | 114 | 118 | $D-A: +\ 25·3$ | Significant |

* *A*: Underweight, that is, 7 per cent or more under normal.
*B*: Slightly underweight, that is, less than 7 per cent under normal.
*C*: Normal and slightly overweight, that is, less than 15 per cent over normal.
*D*: Overweight, that is, 15 per cent or more over normal.
('Normal', according to Baldwin and Wood's Table.)
† Calculated by using reciprocals of means, since short running times indicate good performances.

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Medical Research Committee,
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Oct. 25.

[1] de Jongh, T. W., Cluver, E. H., and Jokl, E., "A National Manpower Survey of South Africa", *Manpower* (Pretoria), 1, 1 (September 1942).

[2] Bogert, L. J., "Nutrition and Physical Fitness" (Philadelphia and London, 1939).

## Analogy between Pseudopodia and Nerve Fibres

A GOOD many years ago, Verworn[1] developed in some detail a supposed analogy between rhizopod pseudopodia and nerve fibres. He suggested that these represent two extreme types of living substance in which the effects of stimulation are transmitted respectively with and without decrement.

Though this suggestion has not proved fruitful as a basis of further research, some points in a recent letter by J. Z. Young[2] on the structure of nerve fibres revive the possibility that it may not be entirely without significance. Both nerve fibres and foraminiferan pseudopodia[3,4] apparently owe their form to the linear arrangement of micellæ, and are thrown into coils when this orientation is disturbed. In both, the internal protoplasm is in a more or less fluid condition and streaming movements can be observed.

Some observations made in the course of a prolonged study of foraminiferan pseudopodia at the Ghargaqa (Red Sea) Marine Biological Station some years ago may be compared with those of Young on the effects of cutting a nerve fibre. When a pseudo

podium is cut, the proximal part is rapidly withdrawn. Sometimes this takes place rather violently, and the pseudopodium is then thrown into loose spiral coils in the process. In the part distal to the cut the streaming movements continue unchanged for some time; but gradually the movement becomes preponderatingly towards the cut, and protoplasm accumulates there in the form of a swollen mass. Little or no movement can be seen in this mass, which is therefore probably more solid than the ordinary pseudopodial protoplasm. Subsequent slow general contraction of the whole of the pseudopodial reticulum distal to the cut results in the withdrawal of this part away from the place of the cut; but usually before this contraction is complete new pseudopodia begin to grow out from various parts of this now enucleated fragment. I have no record of coiling ever occurring during this slow contraction.

Thus, in contrast to the cut nerve fibre, in a cut pseudopodium it is the part connected with the nucleus which shrinks, while the swelling occurs at the distal side of the cut. Coiling only occurs in the nucleated fragment, and then only if the retraction is sudden. The fact that new pseudopodia grow from the enucleated fragment shows that contact with the nucleus is not required in order to orientate the micellæ or chain molecules, the existence of which has to be assumed in order to account for the structure and movements of the pseudopodia.

The weakness of Verworn's analogy lies largely in the fact that the pseudopodium is not to any extent specialized for the purpose of conduction. A stimulus given to one part of the pseudopodial reticulum has no effect on adjacent parts unless it involves a gross mechanical disturbance or a change in the streaming movements sufficient to extend to those parts. Nevertheless, from the point of view of the conditions necessary for maintaining physical stability in fine elongated strands of protoplasm, the larger Foraminifera provide particularly attractive material for study.

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[1] Verworn, M., "Irritability" (Yale Univ. Press, 1913).
[2] Young, J. Z., *Nature*, **153**, 333 (1944).
[3] Lepeshkin, W. W., *Biologia Generalis*, **1**, 368 (1925).
[4] Sandon, H., *Nature*, **133**, 761 (1934).

## Energy Imparted by Active Nitrogen

Spectroscopic evidence[1] shows that the maximum energy of excitation which a molecule of active nitrogen can impart to another molecule (or atom) is 9·45 eV. Lord Rayleigh, however, from a study of the incandescence of metals immersed in active nitrogen, finds[2] that each molecule of active nitrogen delivers to the metal energy of, at the least, 10 eV. These apparently conflicting results can be reconciled and satisfactorily explained on the hypothesis recently proposed by me, namely, that active nitrogen is simply the ionized molecule of nitrogen $N_2^+(X')$ produced by the discharge[3].

The molecules (or atoms) introduced into the vessel containing active nitrogen are excited by a three-body collision process as follows:

$$N_2^+ + e + M \rightarrow N_2\ (\text{excited}) + M\ (\text{excited}).$$

Now, the lowest electronic level of excitation to which $N_2$ can drop, on neutralization, is the $A$-level, with energy 6·1 eV. The levels lying immediately below it are high vibrational levels of the ground state ($X$) with distances of nuclear turning-points very different from the nuclear separation of $N_2^+(X')$. Transitions to any of these levels will violate the Franck-Condon principle. The maximum energy left over for exciting the third body is thus $15{\cdot}58 - 6{\cdot}1 = 9{\cdot}48$ eV. This explains why repeated attempts by spectroscopists have failed to produce excitation levels above 9·45 eV.

The possible levels below the $A$-level to which the neutralized $N_2$ molecule can drop are the ground-level ($X$) and a few of the vibration-levels immediately above it. But this would mean that nearly the whole of the energy of ionization is either radiated away or is taken up by $M$. The reaction in this case would be:

$$N_2^+ + e + M \rightarrow N_2\ (\text{normal state}) + M\ (\text{excited state}).$$

I do not know if the probability of such reactions has been studied. In my opinion the probability would be very small.

To explain the higher value of energy as obtained by Rayleigh we recall that for neutralization of $N_2^+$ on the surface of a solid, the latter acts as the third body. The electrons first arrive on the surface of the solid and remain there as surface charge. The $N_2^+$ ions then arrive and combine with the electrons, giving up the energy of recombination to the solid surface. Since the solid, with its complicated structure, has many modes of vibration, it can take up the whole of the released energy, 15·58 eV. This, in other words, means that though spectroscopically active nitrogen can impart energy only up to a maximum of 9·45 eV. to an atom or a molecule, it can impart much greater energy (15·58 eV.) to the surface of a solid. This explains the apparently conflicting results mentioned above.

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c/o Royal Society,
London.
Nov. 10.

[1] Okubo, J., and Hamada, H., *Phil. Mag.*, (7), **5**, 272 (1928).
[2] Rayleigh, Lord, *Proc. Roy. Soc.*, A, **176**, 17 (1940).
[3] Mitra, S. K., *Science and Culture* (Calcutta), **9**, 49 (1942–43); **10**, 133 (1944–45); *Nature*, **154**, 212 and 576 (1944).

## Permeability of Adsorbing Substances

King has shown[1] that at low concentrations the diffusion constant of water in keratin becomes extremely small in comparison with its value at higher concentrations. This effect is already known from the behaviour of the hair hygrometer[2], the response of which (dependent on the internal diffusion of water in keratin) is much slower at low than at high relative humidities. The magnitude of this effect is shown by the following figures I have obtained for the times ($\tau$) of half-change of the length of hair (of 0·1 mm. diameter) after a sudden small change of humidity, at 18° C.

| Per cent relative humidity | $\tau$ (sec.) |
|---|---|
| 10–25 | 150 |
| 25–34 | 65 |
| 34–49 | 40 |
| 49–63 | 26 |
| 63–75 | 15 |
| 75–92 | < 10 |

That this phenomenon is characteristic not only of keratins but also of other adsorbing substances, for example cellulose, can be shown by a very simple experiment, reminiscent of King's[1], but more suit-

able for obtaining quantitative results. A glass tube is divided into three compartments by two cellulose membranes. After evacuating the three partitions, the end spaces are filled with water vapour of different but constant pressures. The pressure in the intermediate chamber then adjusts itself so that the pressure differences across the membranes are inversely proportional to the diffusion constants. It was found that this pressure was always much nearer to that of the high vapour pressure side, independent of the direction of the diffusive flow. If one side was completely evacuated, the pressure in the middle chamber rose until it was equal to that of the high-pressure side, thus leading to the paradox, mentioned by King, that the amount diffusing may decrease with increasing concentration gradient.

These results can be explained most simply by taking into account two or more states of adsorption of the diffusing vapour in the adsorbing material, in which states the adsorbed molecules have markedly different mobilities. Then Fick's law applies, not to the adsorbed total, but only to the concentration of the mobile part (for keratin, Speakman's "capillary water"[3], and for cellulose Peirce's loosely bound "β-water"[4]) which reach appreciable values only at the higher concentrations of total water. A fuller account of the quantitative relationship between adsorption and the diffusion constant in the case of hair will be given elsewhere[5].

There is some evidence that similar phenomena can occur in the diffusion of adsorbed substances even where no swelling takes place (for example, in the diffusion of dyestuffs through cellulose[6]), though these conditions are complicated by the presence of ions. Here, too, the diffusion 'constant', as in the case of water diffusion, rises with the total concentration of the adsorbed material.

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Nov. 11.

[1] King, G., *Nature*, **154**, 575 (1944).
[2] Spilhaus, A. F., Massachusetts Inst. of Technology, Meteorol. Course. Prof. Notes No. 8 (1935).
[3] Speakman, J. B., *Trans. Far. Soc.*, **40**, 6 (1944).
[4] Peirce, F. T., *J. Text. Ind.*, T. **20**, 133 (1929).
[5] Glückauf, E., *Q. J. Roy. Met. Soc.*, in the press.
[6] Garvie, W. M., and Neale, S. M., *Trans. Far. Soc.*, **34**, 335 (1938).

## Plant Nutrients in the Sea

Two difficulties have been raised by critics of the suggestion that, for the benefit of the fisheries, large-scale addition of plant nutrients to selected parts of the sea may be considered in the future[1]. The first difficulty concerns the quantities of nutrients required; Michael Graham describes these as "mountainous, nay astronomical"[2], and Dr. W. R. G. Atkins, on surer grounds, estimates the annual turnover of phosphorus in the phytoplankton of the English Channel at about one ton for each square kilometre of surface[3]. The quantity is neither astronomical nor even discouraging.

The Agricultural Statistics for 1937, the latest available, show that the quantity of phosphatic nutrients used in the United Kingdom and Eire in that year represented 201,000 tons as $P_2O_5$, equivalent to 2,718 lb. $P_2O_5$ or 1,187 lb. of phosphorus on each square kilometre of all crop and pasture land (41 million acres). But most fertilizers are applied to arable land (13½ million acres), so that the quantity of phosphorus distributed annually on an arable square kilometre is probably more than 3,000 lb. This is considerably in excess of the annual turnover in a square kilometre column of the English Channel. Dutch farmers use about six times as much fertilizer per acre as we do, so that compared with their liberal broadcasting on the surface soil, the turnover in the equivalent column of the English Channel seems almost puny.

The truth is that neither quantity nor cost of fertilizers matters very much to the farmer, provided a profitable return is produced. The return, and not the "mountainous" quantities or "vast expenditure", should be the criterion also in the sea. Furthermore, I conceive that if plant nutrient experiments are ever made in the North Sea, they will at first be limited in extent and confined to areas where currents, plankton and bottom fauna suggest possibilities of success. It seems more reasonable to develop a mediocre into a rich feeding ground with a minimum of labour than to transplant fish from one to the other.

The second suggested difficulty is that the soluble fertilizers once added to the surface waters will be "dissipated into the ocean"[3]. But the indications are that, in suitable areas, the fertilizers are almost immediately converted into phytoplankton, which is rapidly converted into zooplankton and bottom fauna, and no one suggests that the plankton or bottom fauna are dissipated into the ocean. The waters of the sea and their contents are more stable than might be supposed. There will be some loss, but there is considerable loss of fertilizers even on arable land, owing to rainfall and chemical action—the test again must be, are sufficient quantities utilized to make a profitable return? That has still to be decided.

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[1] Ritchie, J., *Nature*, **154**, 275 (1944).
[2] Graham, M., *Nature*, **154**, 366 (1944).
[3] Atkins, W. R. G., *Nature*, **154**, 490 (1944).

## Professional Service in Universities, Technical Colleges and Industry

READERS of the leading article on "Professional Institutions" in *Nature* of December 9 may be interested to know that my Council had in fact taken the initiative in the way suggested in its opening paragraph. The views of the vice-chancellors of the universities and the principals of technical colleges of Great Britain are being sought as to:

(i) The conditions under which scientific workers of different grades in universities and technical colleges should undertake research or consulting work for industry, Government and Government-subsidized organizations.

(ii) The provisions that could usefully be made for the ready interchange of scientific workers between teaching posts, industry and Government service.

The nature of the replies will determine in what way we shall pursue the matter further.

ROBERT H. PICKARD.
(Chairman.)

Joint Council of Professional Scientists,
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at The University,
Reading, Berks.
Dec. 12.

# RESEARCH ITEMS

### Logarithmic Series and the Index of Diversity as Applied to Ecological Problems

IN a recent paper in the *Journal of Animal Ecology* (**32**, May 1944), Dr. C. B. Williams of the Rothamsted Experimental Station discusses this subject. He describes the application of a logarithmic series to a number of problems. It is found to fit extremely well to a large number of frequency series whether they be taken from insects, birds or plants. It also fits well to the number of genera with different numbers of species in standard classifications of groups of both animals and plants. The idea of the index of diversity is applied to problems of the number of species of plants on different areas and to the comparison of floras of different areas with interesting results. The author gives a classification of the 171 families of dicotyledons according to their index of diversity. It is hoped in this way to stimulate discussion of the factors which control differences and resemblances in this index. As a general rule it is found that those families with numerous species and genera have a large index of diversity, but yet there may be a very wide range of index in families of about equal size. This paper is one of considerable interest and deals in the main with problems of species, area and numbers of individuals and with the grouping of species into genera, many examples of both being quoted.

### New Zealand Turridæ

THE Turridæ is the largest family of gasteropod molluscs, and not only does it contain numerous living members, but it also has a large number of fossil representatives extending back with certainty to the Cretaceous if not earlier. In view of its extent and mixture of living and fossil forms it is not surprising that it presents a number of problems. 398 species of New Zealand Turridæ are described and figured in a well-produced memoir by A. W. B. Powell (*Bull. Auckland Inst. and Mus.* No. 2; 1942); 31 genera and subgenera and 144 species are new. The author takes advantage of this large amount of material to treat of several matters of general importance in the family, and includes a section on nomenclature in which he has endeavoured to give a synonymy of the generic names. The 362 names that have been employed are reduced to 284, which he considers are satisfactory both from the points of view of nomenclature and taxonomy. The second of the major general problems is the classification of the group with keys to the sub-families and genera. In this respect it is interesting to notice that classification according to the type of radula cannot be correlated with that based on shell features, but as too few of the radulæ are known it is not desirable to draw useful conclusions from this.

### Fishes from the Panama Bight

John Treadwell Nicholls and Robert Cushman Murphy describe a most valuable collection of fishes based mainly on material from an expedition conducted by the junior author on behalf of the American Museum of Natural History, February–May 1941, using as a base of operations the Diesel schooner *Askoy* ("A Collection of Fishes from the Panama Bight, Pacific Ocean", *Bull. Amer. Mus. Nat. Hist.*, **83**; 1944). The Panama Bight is defined as the part of the Pacific bounded by the concavity of the American coast between the Gulf of Panama and Point Santa Elene, Ecuador, and extending offshore towards the west and south. The pelagic collection at Station 49 (between the Colombian Coast and Malpelo Island) is of special interest. Here was encountered the upwelling of deep water, and the ocean was troubled by vertical waves in completely calm weather, resulting in large surface hauls of deep-water animals. The bulk of the material from this collection, however, was from coral brought up chiefly by the diving operations of Dr. John C. Armstrong, second in command of the expedition. The value of this paper is much augmented by the biological notes taken on the spot from the live specimens. These include descriptions of behaviour and coloration, not only of the captured fishes but also of those observed in their natural surroundings in the sea, such as the 'leaping mantas' which make somersaults in the air, and large sharks.

### Inheritance of Resistance in Melons

S. S. IVANOFF (*J. Hered.*, **35**; 1944) describes the methods and results obtained in raising melons suitable for market which are resistant to downy mildew and aphid attacks. Resistance behaves as a partial dominant during segregation. For example, the number of aphids on susceptible leaves was 433, on $F_1$ leaves 62, and on resistant leaves 4. Similarly, the number of lesions due to the fungus showed incomplete dominance. There would appear to be some connexion between resistance to aphid attack and resistance to the fungal attack, but the mechanism whereby resistance is achieved is unknown. The present resistant characteristics were derived from West Indian varieties of melons. When the original selections from the $F_1$s' were made, powdery mildew was not prevalent, so the new strains do not possess resistance to powdery mildew; but new selections are being made to obtain varieties resistant to all three troubles.

### Changes in X-Ray Sensitivity in Different Stages of Meiosis

A. H. SPARROW (*Proc. U.S. Nat. Acad. Sci.*, **30**, 147; 1944) has irradiated the different stages of meiosis from leptotene to the end of anaphase I in *Trillium erectum* and has compared the number of aberrations at each stage. He finds that if the sensitivity at leptotene-zygotene is 1·0, early pachytene is 2·3, pachytene 1·7, late pachytene 2·6, metaphase 1, 5·9, anaphase 1, 8·7, and microspore resting nucleus between 1 and 1·7. He suggests that the high concentration of desoxyribose nucleotides found at metaphase and the sensitivity to X-ray dosage are correlated. It is concluded that X-ray hits do not induce immediate breaks but potential breaks, which are not actually realized until the following division. The relationships of tumour and radiosensitivity to nucleic acid content are discussed.

### Hot Water Injury of Narcissus Bulbs

THE practice of treating narcissus bulbs with hot water at 110° F. for three hours is now a standard control for internal pests. Occasional subsequent damage to the flowers has been reported, however, and J. Wood (*J. Roy. Hort. Soc.*, 69, Pt. 10; Oct. 1944) has investigated the difficulty. Splitting of the corolla can be minimized by storage at 80° F. instead of 60° F. after lifting and before treatment

with hot water. Early lifted bulbs are also more susceptible to trumpet splitting, whereas late lifting may bring damage to the roots. Storage after treatment should be at a cool temperature of 48° F.

### Limiting Flow of Gas through a Nozzle

As previously mentioned in *Nature* (154, 90; 1944), J. R. Green and R. V. Southwell investigated the two-dimensional flow of a compressible fluid through a nozzle by Southwell's general 'relaxation' method. This method failed when the velocity was *supersonic*, that is, exceeded the local velocity of sound in the fluid. To deal with the supersonic case an iterative method, not depending on 'relaxation', was suggested. This has now been worked out in detail by L. Fox and R. V. Southwell (*Proc. Roy. Soc.*, A, 183, 38; 1944) for irrotational flow with steadily decreasing pressure and density. It is recalled that Osborne Reynolds's early (1886) approximate treatment of the nozzle problem found that the velocity of discharge could never exceed a certain limit, which was attained when the velocity in the narrowest section or 'throat' was equal to the local velocity of sound. He also concluded that there were two and only two possibilities after the gas had left the throat. Either its density and pressure steadily increased as it passed to the exit, or they steadily decreased. One of these two states, it was conjectured, was unstable. No intermediate state was possible. The more exact treatment of the present paper shows that there are *two* slightly different limiting values of the velocity of discharge. One of these is attained when the velocity both before and after the throat is subsonic, though, curiously enough, the velocity has supersonic values at two small regions near the wall at the throat. The other limiting value is for the case when the velocity is supersonic at the part of the nozzle between the throat and the exit. The second value is very slightly greater than the first, by 0·045 per cent. Osborne Reynolds's estimate of the first needs a small increase of 0·083 per cent. The convergence of the iterative process appears to show that the irrotational flow is stable from low velocities up to the lower limit, which gives great stability. On the other hand, the unique supersonic state appears to be unstable, though it may exist. The discussion of the physical interpretation of the work is reserved for a later paper.

### Hydrogen Bonds in Ethyleneimine

ALTHOUGH the existence of N—H—N bonds in nitrogen compounds has often been discussed, the compounds have been relatively complicated, such as pyrazoles, indazoles, amidines, etc. W. H. Thompson and G. P. Harris (*J. Chem. Soc.*, 301; 1944) have found good evidence of hydrogen bonding in the simple compound ethyleneimine. The infra-red absorption band at 3 $\mu$ due to the NH-group in this is appreciably displaced in wave-length on passing from the vapour to liquid, whereas other bonds are not much affected. Solutions in carbon tetrachloride, examined with wave-lengths between 2·9 $\mu$ and 3·5 $\mu$, showed the sharp band at 3·01 $\mu$ in dilute solution giving way at higher concentrations to a broader and more intense band with a maximum at about 3·1 $\mu$. The effect is precisely similar to the 'association' band found with hydroxylic substances, and points to association through N—H—N bonds. This is supported by boiling point relations.

### The Faintest Star

THE March issue of *Sky and Telescope* contains an account of van Biesbroeck's discovery of a faint companion to the star BD+4·4048°; Science Service has also described the discovery. Van Biesbroeck was comparing two plates taken at the prime focus of the 82-in. McDonald Observatory reflecting telescope when he discovered the companion of magnitude 18 at a separation of 74″ from the brighter star of magnitude 9·5. This separation corresponds to a distance of about 440 astronomical units, the distance of the system being nearly 20 light-years. The absolute magnitude of this star is 19 as compared with 5 for our sun, and about a million of these faint stars would be required to produce a combined brilliance equal to that of the sun. Owing to its great distance from the brighter star, it is almost certain that it shines, not by reflected light, but by its own light, and hence is a real star, not a planet. In the case of the invisible companion of 61 Cygni, the mass but not the luminosity were determined, and as its mass was about sixteen times that of Jupiter it was classified as a planet. If van Biesbroeck's new star has a mass comparable with that of the companion to 61 Cygni, it seems highly possible that the distinction between planet and star may cease to exist. Information which may be of assistance to astronomers is as follows: The position angle of the faint star is 150°; the common proper motion is 1·45″ towards position angle 204°, and the parallax is 0·17″.

### The Solar Eclipse of June 19, 1936

S. VSESSVIATSKY and E. Bougoslavsky, Kiev Astronomical Observatory, Sverdlovsk, U.S.S.R., deal with the coronal structure and the relationship observed between chromospheric and coronal phenomena during this eclipse (*Mon. Not. Roy. Astro. Soc.*, 104, 3; 1944). Four standard chronographs were located in the path of the eclipse at Beloretchenskaya, Ural, Omsk and Kuibyshevka, and thirty excellent plates of the corona and chromosphere were obtained. A number of important conclusions were deduced as a result of the work, but these cannot be dealt with in full. A very brief outline of them is as follows: Phenomena in the chromosphere and in higher-lying coronal regions are due to foci or centres of excitation on the sun's surface. Their frequency as well as their peculiarities of distribution are related to the heliographic latitude and they change with phases of the sun's activity. The coronal arch systems and the fan forms involved occasionally take on a helmet-shaped summit. This changes into thin rays distributed over the centres of excitation, these rays being connected by dark fibrous formations or dark flocculations. In the chromosphere, excitation gives rise to prominences which are 'imprisoned' in the interior of the coronal arch systems. The fan-shaped forms which characterize the structure of the corona over excited areas of the sun's surface have a discrete structure and represent a system of successive arches. From the presence of the helmet-shaped summits observed on many of the fans it is inferred that there are vertical fields in different regions of the corona at distances of ½ to 2 solar radii. The influence of the general field of the sun is reflected in the peculiarity of the inclination of the axes of the fans to the normal and also by the change in their inclination in relation to the phase of solar activity. This influence is also shown by the existence of a weakened luminosity inside the corona in a narrow equatorial belt of width about 7°.

# THE WILLOW TREE (*Salix* sp.)

By ALEXANDER L. HOWARD

"There is a willow grows aslant a brook
That shows his hoar leaves in the glassy stream".
SHAKESPEARE.

AMONG the many trees which adorn the countryside of Britain, this tree is one of the best known, and especially to those whose lives have been spent from earliest childhood in the country. A great many people have earned their livelihood in one way and another from its products, but those who have interested themselves in conserving or replenishing the stock are far too few, and almost entirely confined their attention to the bat willow, although perhaps with the exception of the ash tree the willow is one of those which will repay the planter within the least number of years. The fisherman, the basket-maker, and the gipsy are very intimate with the particular species which they know about, the first-named because of his continued controversy with the overhanging branches which interfere with his sport, but the latter since it has contributed to their livelihood.

It is unnecessary to describe the leaf or appearance of the tree, as it is so well known. Indeed, the narrow-pointed leaf, unlike most of our broad-leaved trees, is so prominent that its name has been borrowed for the description of other trees, such as the willow oak (*Quercus phyllus*), etc.

Everyone must be quite familiar with what we know as 'the willow pattern' of Chinese and Japanese origin in pictures and china ware; and also with the blue willow pattern of our own china, and more lately when a great designer made use of this attractive medium by the introduction of it into wall-papers. The Morris willow pattern also has become a well-known and admired addition to our domestic art. Whether the original Chinese, etc., pictured the willow as we know it is in some doubt. It has been suggested that perhaps the tree *Koelreuteria*, also a native of China, inspired the original willow pattern. While it would be interesting to decide the point, the beauty and likeness of both these trees is the principal subject of our interest.

The willow tree is regarded by different people with strangely opposite views: some think it a dull tree and take little interest in it, while others are delighted with the graceful form of the foliage and leaves, and its association with the banks of streams and rivers. The silvery blue presented by the leaves of many trees waving in the breeze adds greatly to the beauty of the landscape in those parts of the country frequented by the heron, the snipe and the duck. By the banks of streams, and in osier beds and the like, the willow figures more as a bush than a tree, and here it serves the purpose which it shares with the alder, of consolidating the banks, preventing erosion.

If care, and the study and practice of scientific measures are adopted, the tree will yield a very satisfactory financial result to the grower; but to succeed, diligence and study are required.

General knowledge is limited to two or three kinds, but Elwes mentions more than a hundred and sixty species, and Loudon more than two hundred. Many of these have been introduced from other countries.

The male and female trees of the original indigenous kinds have become the progenators of numbers of hybrids. I shall limit my remarks to seven kinds which are the better known and most prominent, namely: white willow, cricket bat willow, goat willow, bay willow, crack willow, golden willow, and the weeping willow.

## White Willow (*Salix alba*)

In single form this tree will attain a height of more than 100 ft., with a girth of 25 ft. 6 in., but generally speaking large-sized trees are not common. The white willow (*S. alba*) with its close relative *S. alba coerulea* are by far the most important, as these two yield the best wood for the making of cricket bats. *Salix alba* may easily be recognized by 'witches brooms'—a formation caused by a mite (*Eriophes salicis*).

Elwes mentions:

"a tree at Bury St. Edmunds, figured by Strutt . . . as the Abbot's willow, is one of the largest white willow of which we have record. It was measured . . . in 1822, when it was 72 ft. high by 18½ ft. in girth, and was estimated to contain 440 ft. of timber".

Inquiries at Bury St. Edmunds to-day (1944) fail to reveal any information about this tree, and for many years it has been inquired for with no better results.

## Cricket Bat Willow (*S. alba coerulea*)

This is a tree the origin of which would seem to be obscure, but it has been known in Great Britain since the beginning of the nineteenth century. It will attain a height of perhaps 100 ft. Of this Elwes says:

"Many trees of remarkable size, but comparatively young, have been felled for conversion into cricket bats. One of the largest was a tree at Boreham, Essex, which was planted in 1835, and felled in 1888, when it was 101 ft. high and 5 ft. 9 ins. in diameter. It weighed upwards of 11 tons, and was perfectly sound. It was felled by B. Warsop & Sons, who made from it no less than 1,179 bats".

Elwes was not often mistaken; but it would seem doubtful if any tree could make such growth in fifty-three years, as would equal more than one inch for every year.

He also says:

"Mr. Stuart Surridge purchased for £25, in 1910, a tree near St. Albans, which was about 80 ft. high and measured 5 ft. in diameter at 3 ft. from the ground. Judging from a photograph, it had a clean stem of about 16 ft. He states that the largest tree known to him grew at Robertsbridge, in Sussex, and measured 21 ft. in girth. This was felled in 1902, and produced over 1,000 cricket bats".

Mr. D. N. Bridger informs me that one of his workmen well remembers this tree being cut down and cleft. Mr. Bridger says that all the trees of *S. alba coerulea* are female, and he also says that many trees of *S. alba* have provided as good timber for cricket bats as *S. coerulea*. Elwes says, however, that the wood of *S. alba* is used for making cricket bats of an inferior kind. I also recall an occasion when an indignant purchaser of what he thought would prove to be cricket bat quality was informed that he had purchased the product of *S. alba* when he should have purchased *S. alba coerulea*. After exhaustive study I think the best results could be expected from the last-named, but it is quite possible that in the last thirty to forty years the character of the trees which have reached maturity may have altered.

The cricket bat manufacturer has become expert in his selection of the trees, but the same knowledge is not general among those who would find it to their advantage to become planters. Mr. Bridger emphasizes the importance of an abundant provision for the future of the cricket-bat making industry, his estimate of the annual output being in the neighbourhood of 250,000 bats per annum, men's size alone, while others name an even higher figure.

In 1915, it was discovered that in tropical countries, where the white ant has become a major pest, artificial limbs became a prey to these insects, and Prof. Groom and I were asked to find a wood which was immune to this attack. Exhaustive inquiry failed to discover anything except the willow suitable for the purpose, and in reply to an inquiry this year (1944) at the hospital at Roehampton, Mr. A. W. Shaw confirms the opinion, and says:

"willow is still the wood used in relation to wooden artificial legs, and no other wood has yet been found suitable. For metal artificial legs the foot is of willow".

The wood is pinkish-white, with a tough but softish grain, and besides the before-mentioned uses, provides the best-known timber for trug baskets, fruit baskets, linings for carts, barrows, and brakes for railway and other wagons, being especially good for the last-named, as it does not fire so readily as other woods from the friction of the wheels.

### Goat Willow (*Salix caprea*)

This tree is naturally regenerated by seed, but can be propagated by cuttings and by sets. Its principal value is for prevention of erosion, and it is used for making fences and sheep hurdles, for trug baskets and for handles of rakes.

### Bay Willow (*Salix pentandra*)

This is more noticeable for its attractive foliage than for its uses; it is distinguishable by its broad shining leaves.

### Crack Willow (*Salix fragilis*)

This is sometimes called 'open-bark' willow. The wood is of little importance, but the Rev. C. A. Johns tells us that "the roots afford a purple-red dye, and are still used in Sweden and in France to colour Easter Eggs".

### Golden Willow (*Salix vitellina*)

This tree is familiar to most people, and can be found in many gardens, parks and pleasure grounds. Fortunately, the nurseryman has found it sufficiently attractive to warrant production in large numbers, so that of late years householders have been able to gratify their inclination to make their gardens ornamental, and in this manner the tree has been justly introduced on a scientific scale. Elwes says:

"we have seen no trees of great size, the finest being probably two trees at Glasnevin, which are about 65 ft. in height and 8 ft. in girth".

The tree should be encouraged for its unusual grace and beauty.

### Weeping Willow (*S. babylonica*)

There must be very few who have not enjoyed the beauty of the weeping willow, a tree much more commonly seen half a century ago than to-day, and one which, if the plans for re-afforestation for the future are limited alone to the economic aspect, may insensibly vanish from our landscape.

It would appear that the first tree introduced to Great Britain was planted at Twickenham, and became famous, for Johns tells us:

"the first tree was planted at Twickenham, either by Mr. Vernon, a merchant of Aleppo, or by Pope. This was a favourite tree with the poet, and after his death became the object of so much curiosity that the possessor of his villa cut it down, to avoid being annoyed by persons who came to see it".

He also says:

"Loudon informs us that this tree was introduced into St. Helena from Britain by General Beaton, 1810. It was planted among other trees on the side of a valley near a spring; and having attracted the notice of Napoleon, he had a seat placed under it, and used to go and sit there very frequently, and have water brought to him from the adjoining fountain. About the time of Napoleon's death, in 1821, a storm shattered the willow in pieces, and after the interment of the Emperor, Madame Bertrand planted several cuttings from it on the outside of the railing which surrounded the grave. As none of these flourished, they were renewed in 1828; and from one of them, which outstripped the rest, were brought most of the cuttings which have been reared in various parts of the country. The oldest now in existence in Europe derived from this stock stands in the garden of the Roebuck Tavern on Richmond Hill".

And again:

"So popular has the weeping willow become as an ornamental tree, that it is said to be commoner in almost every country than in its native habitat, the banks of the Euphrates".

We are accustomed to the introduction of fashions in many directions, but it is curious that this should apply to the planting of particular trees. Sometimes the fashion has been to plant oak, another time acacia, and further instances might be quoted. Following the reign of terror and the Napoleonic era, certainly a wave of fashion spread over Europe, including Great Britain, for the planting of weeping willows, so that almost all the gardens and parks which date from this period included it among their ornamental trees.

Elwes gives some interesting information relating to this tree, and says:

"this was the name given by Linnaeus to the common weeping willow cultivated in Europe, which he erroneously supposed to have been identical with the trees growing by the rivers of Babylon, which are mentioned in Psalm cxxxvii, 1, 2.

"By the rivers of Babylon,  
There we sat down, yea, we wept,  
When we remembered Zion.

Upon the willows in the midst thereof  
We hanged up our harps.

"The latter are, without doubt, a species of Poplar (*Populus euphratica*). . . . The best that I have seen is perhaps a tree on the Promenade, Cheltenham, which was planted about 1860, and is still thriving, although its limbs have been supported by iron rods for some years. It measured in 1911 about 75 ft. by 9 ft. and on 24th November, 1911, after a severe frost, it still retained most of its leaves.

"There are several picturesque trees, but of no great height, growing on the banks of the Cam, behind the Colleges of Cambridge. These are exceeded in size by one

in the Fellows' Garden of King's College, which was about 45 ft. high and 10 ft. in girth in 1912, with the trunk decayed and mended with cement".

The weeping willow is surprisingly distributed. In addition to the numberless places in Asia and Europe where it thrives, Elwes informs us that "it attains much greater size and beauty in warm countries than it does in England" and that he had "seen none finer than in Chile".

# THERMODYNAMICS OF SORPTION ISOTHERMS: THE HYSTERESIS LOOP IN CAPILLARY CONDENSATION

By Dr. D. H. BANGHAM
British Coal Utilisation Research Association

IN any two-component system if $m_A$, $m_B$ are the masses of the components $A$ and $B$ and $g_A$, $g_B$ their respective Gibbs free energies *per gram*, then so long as there is equilibrium,

$$SdT - VdP + m_A dg_A + m_B dg_B = 0, \quad . \quad . \quad . \quad (1)$$

where $S$ is the entropy and $V$ the volume of the 'complex' of $A$ and $B$ whatever form it may take. If the 'complex' contains only condensed phases and the pressure is kept substantially constant (say, below 1 atmosphere) we can disregard the second term, and write for isothermal equilibrium:

$$m_A dg_A + m_B dg_B = 0 \quad . \quad . \quad . \quad . \quad (2)$$

An advantage of (2) over the more usual form of equation in terms of molecular quantities is that it is immediately applicable in cases where the molecular weight of one of the components (say, $A$) is large or unknown; it is particularly helpful, therefore, in examining the sorption relations of gels, the interaction between solid polymer and 'plasticizer', and such cases. Supposing $B$ to be a volatile liquid of molecular weight $M$, and that the 'complex' is at equilibrium with the vapour of $B$ at a pressure $p$, $f$ being the corresponding fugacity, we have, on substituting $RT/M \, d\log_e f$ for $dg_B$,

$$m_A dg_A + \frac{m_B RT}{M} \, d\log_e f = 0$$

$$g_A{}^0 - g_A = -\frac{RT}{M} \int_0^p \frac{m_B}{m_A} \, d\log_e f \quad . \quad . \quad . \quad (3)$$

where $g_A{}^0$ is the (Gibbs) free energy of *pure A*. The right-hand member of this equation can be evaluated experimentally.

The only conditions attached to the validity of (3) are that the structure and composition of $A$ should be statistically uniform (so that $m_B/m_A$ has a definite meaning) and that the same equilibrium should be attained by approach from either side. Primarily, we do not need to ask ourselves whether or not a true chemical compound is formed, whether the 'complex' is to be regarded as a one- or as a two-phase system, whether $B$ is or is not molecularly dispersed (to give a true solution), or whether, supposing surface interactions are involved, these are taking place at plane or at curved surfaces. In fact, however, a large number of cases have come to light where the relation between $(g_A{}^0 - g_A)$ and $m_B/m_B M$ corresponds to well-recognized two-dimensional equations of state or to a sequence thereof[1,2,3]. Where this occurs it appears justifiable, *prima facie*, to infer that: (1) $B$ is adsorbed as a film at the surface of $A$; (2) $A$ is characterized by possession of a definite surface area ($\Sigma$) per unit weight; and (3) that $(g_A{}^0 - g_A)$ stands for a decrement of *surface* energy and can be equated to $\Sigma(\gamma_0 - \gamma)$, where $\gamma_0$ is the surface energy of $A$ *in vacuo* and $\gamma$ its value in contact with the vapour of $B$ at $p$. It is convenient to assign the symbol $\Pi$ to $(\gamma_0 - \gamma)$ and regard $\Pi$ as a two-dimensional 'film pressure'; thus

$$\Pi\Sigma = (\gamma_0 - \gamma)\Sigma = \frac{RT}{M} \int_0^p \frac{m_B}{m_A} \, d\log f \, . \quad . \quad . \quad . \quad (4)$$

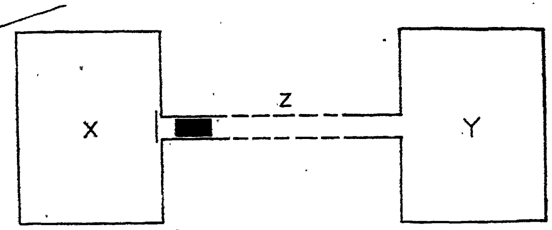
Now the sorption relations of many gels are such as to suggest the *filling-up* of capillary spaces, the quantities of different adsorbates at saturation representing roughly equal volumes of the different liquids[4]. According to the well-known capillary condensation hypothesis, the quantities sorbed at pressures below saturation are determined by the distribution of pore radii (the pores usually being considered cylindrical), the surface tensions $\gamma_B$ of the liquids, and the equilibrium angles of contact $\theta$, the relation between these parameters being the Kelvin equation:

$$p/p_0 = \exp.(-2V_m \gamma_B \cos\theta / rRT), \quad . \quad . \quad . \quad (5)$$

where $p_0$ is the saturation pressure of the liquid and $V$ its molecular volume. A necessary condition for capillary condensation is that $\theta < 90°$. Several authors have attempted to derive 'structure curves' for pore-size distributions from their sorption data on the basis of equation (5), $\theta$ generally being taken as zero. A weak point about this procedure is that, apart from its ability to become wetted by the component $B$, the only adjunct of A that is allowed to have a determining influence is the single property of *curvature*: $p$ should thus be uniquely determined by $r$.

By the use of equation (4), on the other hand, Gregg[2] has brought to light instances hitherto universally accepted as examples of capillary condensation, but in which the relations between $\Pi$ and the surface concentration reproduce in detail those of certain insoluble films on water. As the concentration rises, first a 'vapour', then an 'intermediate' and finally a 'liquid expanded' (or 'liquid condensed') film is formed. Thus, at the hands of different workers, the same sorption data may receive mutually incompatible interpretations in terms of film-forming characteristics on one hand and of pore structure on the other. The issue is complicated by the appearance of a hysteresis loop in some of the experimental adsorption isotherms referred to[5]; for over the range of the hysteresis the basic requirement of equations (1)–(4), namely, that the equilibria should be independent of the direction of approach, is no longer satisfied. For this reason we shall resort to the more cumbrous method of argument based on work cycles in the discussion which follows of the tenets of the capillary condensation hypothesis.

We suppose two large enclosures $X$ and $Y$ containing the vapour $B$ at pressures $p$ and $(p - dp)$ respectively, the corresponding fugacities being $f$ and $(f - df)$. Connecting $X$ and $Y$ is a long length of capillary tubing $Z$ of suitable material and of such (uniform) diameter that according to (5) capillary




condensation will just take place at $p$. $Z$ has a shutter at the end nearer $X$. Fitting into $Z$ also is a light piston of such diameter that as it moves it leaves the adsorbed film undisturbed, and merely prevents the liquid from leaking past. The following cycle is carried out isothermally: (1) $Z$ is first exposed to the vapour in $Y$, so that the adsorption equilibrium is established at $(p - dp)$, the shutter at $X$ being closed. (2) The piston being in position at the end of $Z$ nearer $X$, the shutter between $X$ and $Z$ is opened. Capillary condensation thus takes place, the piston being driven back. If $\Sigma$ is the internal area of the tube (more strictly that of the adsorbed film) the maximum work obtainable from the system by the pressure on the piston is $\Sigma\gamma_B \cos\theta$. (3) $Z$ is shut off from $X$ and (after removing the piston) exposed to $Y$, permitting the vaporization of the capillary-condensed molecules. According to the capillarity hypothesis based on equation (5), this process is *spontaneous*, so that *no work need be done* on the system. (4) The appropriate number of molecules of $B$ is compressed from $(p - dp)$ to $p$ and transferred back to $Y$.

The cycle as outlined contravenes the second law of thermodynamics, as indeed must any cycle in which the isothermal transfer of molecules from $X$ to $Y$ is made to yield a finite amount of work. The infringement lies in the assumption (implicit in calculations based on the Kelvin equation (5) ) that the capillary-condensed liquid will evaporate spontaneously at $(p - dp)$.

The essential requirement for compliance with the second law is that, if the tube fills at $p$, the fluid filling the tube should be able, without evaporation, to reduce its free energy by $RT\ d\log f$. This necessarily implies that $\gamma\cos\theta$ is a function of $p$; for $V_m$ cannot vary unless $\gamma\cos\theta$ varies. It follows that if we attempt to empty the tube by isothermal evaporation alone (as opposed to pushing the liquid out simultaneously with a piston) we must reduce the pressure in $Y$ by a *finite* amount to $(p - \Delta p)$. In other words, there will be a *hysteresis* loop in the isotherm.

To sum up, it has been established that: (1) where capillary condensation occurs, $\gamma\cos\theta$ is variable and not constant; and (2) capillary condensation cannot occur without hysteresis, though the converse statement does not necessarily hold. It further suggests itself that a quantitative relation must exist between the area within the loop and the work $\Sigma\gamma\cos\theta$. This relation and the more general form of equation (4) required to cope with cases of hysteresis and capillary condensation will be discussed in a later communication.

[1] Bangham and Fakhoury, *J. Chem. Soc.*, 1324 (1931). Bangham, Fakhoury and Mohamed, *Proc. Roy. Soc.*, A, **147**, 152 (1934).
[2] Gregg, *J. Chem. Soc.*, 696 (1942).
[3] Harkins and Jura, *J. Amer. Chem. Soc.*, **66**, 1356 (1944).
[4] Anderson, J. S., *Z. phys. Chem.*, **88**, 191 (1914).
[5] Gregg (*loc. cit.*) explains such cases in terms of a delayed phase-change.

## THE FAILURE OF PATULIN

IN an earlier issue (*Nature*, 152, 619; 1943), account of patulin was given, and the results of clinical trial of it for the treatment of the common cold, conducted by Surgeon Commander W. A. Hopkins, R.N., with the aid of Naval personnel, as described in *The Lancet* (ii, 625, Nov. 20, 1943), were outlined. In that trial 57 per cent of the patients recovered completely in 48 hours, while only 9·4 per cent of the controls recovered in this time. Commander Hopkins was, however, wisely cautious about the interpretation of these results and pointed out that the etiology of the common cold is not yet fully understood. Prof. H. Raistrick stated at the time that patulin would not be issued for general use until the results of large-scale trials had been obtained. *The Lancet* now publishes the results of two such trials, which fully justify the earlier caution about the effect of patulin on the common cold.

J. M. Stansfield, A. E. Francis and C. H. Stuart-Harris (*The Lancet*, 370, Sept. 16, 1944) report on their laboratory experiments with patulin and on two clinical trials with it for the treatment of colds in 100 soldiers of an army primary training wing. For the second of these trials the method of administration used was the same as that used by Hopkins. Briefly, their conclusions are that patulin is bacteriostatic against a wide range of both Gram-positive and Gram-negative organisms, although its bacteriostatic action is materially reduced by incubation in broth or by the addition of horse serum. The margin between concentrations which kill mice and those which are bacteriostatic *in vitro* is small. Two experiments with mice indicated that it failed to cure infections with *Bact. typhosum* or with influenza virus A. (Hopkins (*loc. cit.*) found that patulin did not appear to have influenced the course of influenza in five human patients.) Controlled clinical trials for the treatment of the human common cold showed no advantage from the use of patulin as compared with the use of control buffer solutions without patulin, and that patulin did not appear to be useful for the treatment of human conjunctivitis.

Another trial (*The Lancet*, 373, Sept. 16, 1944) was more extensive. It was conducted by the Patulin Trials Committee of the Medical Research Council, the chairman of which was Prof. H. P. Himsworth; the committee included Prof. Raistrick and Dr. C. H. Andrewes. For this trial 668 patients were treated and there were 680 controls, the subjects being personnel of the Post Office, the Ministry of Supply, Haileybury and Rugby Schools and various engineering and electrical firms. The conclusion of this Committee is that "In a large clinical trial of patulin in widely distributed areas of Great Britain and lasting from the beginning of December 1943 to the middle of April 1944 no evidence was found that patulin is effective in the treatment of the common cold".

Thus ends a manful and commendable attempt to control that bugbear of our lives, the cold in the head, the effects of which are so great that it is not surprising that uninstructed people rushed into print to claim for patulin more than it could perform. It should not be forgotten that those who produced it never exceeded the scientific scepticism which awaits proof before it commends, and even then avoids exaggerated claims. Meanwhile, much has been learnt from these trials. All those who have conducted them emphasize the difficulty of assessing the effect

...nt of a condition like the common cold, in ...here are no real objective signs by which ...patient's subjective feelings can be checked. All the investigators made provisions for this and endeavoured to eliminate the subjective element. The experience thus gained will be of great value when further remedies are presented for test.

...cussing these trials, *The Lancet* suggests that ...d results obtained by Hopkins may have been ... the effects of patulin on the particular organ... responsible for the colds which he treated, or ... in view of patulin's failure in the later Army Medical Research Council trials, its success in the Navy trials was one of those rare events which ... sometimes happen.

Whether patulin may yet have other uses, further work will doubtless show. G. LAPAGE.

## THE HEATHER BEETLE

THE British Field Sports Society has recently issued a booklet entitled "Report on the Biology and Control of the Heather Beetle". In view of the damage caused by this insect in the past, this report and its findings will be of very definite interest to those who are concerned with the management and preservation of moorlands. These include not only the moor owner and his shooting tenants, but also the sheep grazier and, to a lesser degree, the bee-keeper. The activities of this beetle deplete the numbers of grouse, impoverish the grazing and decrease the honey-flow. The report under notice is based upon investigations carried out between 1937 and 1940 under the direction and supervision of Dr. ...E. Cameron, of the Department of Agriculture and Forest Zoology, University of Edinburgh.

The beetle in question is *Lochmœa suturalis*, a member of the family Chrysomelidæ. Severe damage ... the heather is most prevalent in Scotland; it is ... troublesome in Germany and Holland. In July ... August, the leaves and stems of heather attacked ...he larvæ of the beetle become fox-red where ...y have been chewed and partially stripped of ...k and especially the ends of young shoots. The ...t severe damage is done to old heather of twenty ...s or more. Young heather is also attacked but permanent damage rarely happens. Attacks are most prevalent and the beetles most abundant over flat wet moorlands, but well-drained slopes are not often affected. The eggs of the beetle require humid conditions for their development and are chiefly laid on *Sphagnum* moss. Rainfall in spring and early summer during its breeding season is believed to determine its rate of multiplication. Seasons of very low precipitation seem, on the other hand, to check its activities. There is only one generation in the year. The beetles overwinter in the ground or among moss, etc., and begin to lay eggs in mid-April. Incubation lasts three to four weeks in Nature, and hatching of the larvæ begins early in June ...n they climb the plants in order to feed on ... young shoots and leaves. The adult beetles ...ear first in the latter half of August but do not become abundant until late in September. Ling heather, *Calluna vulgaris*, is the chief and perhaps the only food plant of this insect. The only natural enemy of any importance was found to be the ladybird *Coccinella hieroglyphida* which, however, did not appear to exert any significant degree of control of the beetle.

The problem of dealing with the insect is a question of moorland economics. Treatment of the heather with derris and pyrethrum dusts serves to check the larvæ. General adoption of this method over wide areas of moorland is out of the question owing to the costs of material and labour. Muir-burning in Scotland is not permissible at the time it would be most efficacious. There is no practice of moorland management that should be more encouraged than a ten-year rotational system of burning, since it induces young growth which recovers more quickly from beetle attack than does old heather. Dusting and burning, however, are of secondary importance to drainage. The elimination of excessive moisture by a proper system of surface drains is the only known means by which permanent control of the pest may be achieved.

This report, it may be added, can only be obtained direct from the British Field Sports Society, Petworth, Sussex, price 1s. post paid. It is well printed and, with thirteen full-page half-tone plates, is remarkably cheap.

## FORTHCOMING EVENTS

### Monday, January 1

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S.W.7), at 2.30 p.m.—Mrs. Harold Ingrams: "Young People of the Hadhramaut" (with films) (Christmas Lecture for Young People).

### Tuesday, January 2

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Harold Spencer Jones, F.R.S.: "Astronomy in our Daily Life", 3: "How we get our Time" (Christmas Lectures).

INSTITUTION OF CIVIL ENGINEERS (WORKS CONSTRUCTION DIVISION) (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Lieut.-Colonel C. M. Norrie: "The Organization of Civil Engineering Work".

### Wednesday, January 3

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Lieut.-Commander Rupert T. Gould: "The Art of Measuring Time" (Dr. Mann Juvenile Lecture).

### Thursday, January 4

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Harold Spencer Jones, F.R.S.: "Astronomy in our Daily Life", 4: "Finding the Longitude" (Christmas Lectures).

### Friday, January 5

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S.W.7), at 2.30 p.m.—Surgeon-Commander Bingham: "Sledging with Dog Teams in the Antarctic" (with films) (Christmas Lecture for Young People).

### Saturday, January 6

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Harold Spencer Jones, F.R.S.: "Astronomy in our Daily Life", 5: "Clocks and Time Keeping" (Christmas Lectures).

## APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

IRRIGATION ENGINEER, Soils Mechanics Laboratory, Irrigation Department, Ceylon—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. E.1258.A) (January 1).

INSPECTOR OF AGRICULTURE, Sudan Government—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3285.XA) (January 2).

EXECUTIVE ENGINEER by the Government of Trinidad—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. E.1266.A) (January 3).

ANALYTICAL CHEMIST for manufacturers engaged on high priority work, S.E. London area—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F.3292.XA) (January 4).

EXPERIENCED ENGINEERS, QUANTITY SURVEYORS and ARCHITECTS at the Building Research Station, Garston, Watford, for work in connexion with the preparation of codes of practice—The Ministry of

Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. E.1084.A) (January 4).

ELECTRICAL ENGINEER (temporary staff) by the Nigerian Government Public Works Department—The Ministry of Labour and National Service, Central Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. D.926.A.) (January 9).

ASSISTANT LECTURESHIP IN MECHANICAL ENGINEERING, and an ASSISTANT LECTURESHIP IN ELECTRICAL ENGINEERING—The Registrar, College of Technology, Manchester 1 (January 12).

ENGINEER and MANAGER OF THE HARROGATE WATER UNDERTAKING—The Town Clerk, Municipal Offices, Harrogate (endorsed 'Water Engineer') (January 15).

ASSISTANT CYTOLOGIST to take part in routine and research investigations on Cancer—The Secretary, Royal Cancer Hospital (Free), Fulham Road, London, S.W.3 (February 1).

SENIOR CENTRIFUGAL PUMP DESIGNER for a firm in the South Midlands—The Ministry of Labour and National Service, Central (T. and S.) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. C.2396.XA) (February 4).

## REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

### Great Britain and Ireland

Eighth Report from the Select Committee on National Expenditure, Session 1943–44. The Chemical Controls. Pp. 12. (London: H.M. Stationery Office.) 2*d.* net. [1611

Ministry of Education. Memorandum on the Draft Bu ng Regulations: Being the Draft dated November 3, 1944, of the Leg lations prescribing Standards for School Premises, 1944, proposed to be made under Section 10 of the Education Act, 1944. Pp. 24. (London: H.M. Stationery Office.) 6*d.* net. [1611

Evolution—Fact or Fable: or, Do We Really Come from an Ape-like Stock? By R. L. Wheeler. Pp. 42. (London: The Author, 111 Capel Road, E.7.) [1711

Recruitment to Established Posts in the Civil Service during the Reconstruction Period: Statement of Government Policy and Civil Service National Whitley Council Report. (Cmd. 6567.) Pp. 24. (London: H.M. Stationery Office.) 4*d.* net. [2311

British Library of Political and Economic Science. Annual Report, 1943–44. Pp. 20. (London: London School of Economics and Political Science.) [2311

Ministry of Health and Department of Health for Scotland. Interim Report of the Inter-Departmental Committee on Dentistry. (Cmd. 6565.) Pp. 26. (London: H.M. Stationery Office.) 6*d.* net. [2311

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 15, No. 2, September 1943. Compiled by Agnes Elisabeth Glennie, assisted by Janet Lang Hall Keuneman. Pp. iv+87–158. (London: H.M. Stationery Office.) 4*s.* 6*d.* net. [2311

Association of University Professors and Lecturers of the Allied Countries in Great Britain. Second Education Conference, April 15, 1944: Some Comparisons between Universities. Pp. xvi+64. (Oxford: Basil Blackwell.) 2*s.* 6*d.* net. [2311

University of London: University College. Calendar, Session 1944–1945. Pp. xxxv+132. (London: Taylor and Francis, Ltd.) [2311

Experimental Researches and Reports published by the Department of Glass Technology, the University, Sheffield. Vol. 25, 1942. Pp. iii+286. (Sheffield: The University.) 21*s.* [2911

Amgueddfa Genedlaethol Cymru: National Museum of Wales. Thirty-seventh Annual Report, 1943–44. Pp. 34. (Cardiff: National Museum of Wales.) [412

Proceedings of the Royal Society of Edinburgh. Section B (Biology). Vol. 62, Part 1, No. 5: On the Interpretation of Electrocephalic Potentials. By Dr. C. A. Beevers. Pp. 43–50. 1*s.* 3*d.* Vol. 62, Part 1, No. 6: The Tumour Virus disseminated from Rous No. 1 Tumours. By J. G. Carr. Pp. 51–53. 6*d.* Vol. 62, Part 1, No. 7: Lack of Transmission of Avian Tumour Virus from Carrier Hens to their Offspring via the Egg. By J. G. Carr. Pp. 54–58. 9*d.* Vol. 62, Part 1, No. 8: Action of Sex Hormones on the Adrenal Cortex of the Golden Hamster. By Dr. O. Peczenik. Pp. 59–65. 1*s.* 6*d.* Vol. 62, Part 1, No. 9: The Validity of the Bunsen-Roscoe Law in the Production of Mutations by Radiations of Extremely Low Intensity. By S. P. Ray-Chaudhuri. Pp. 66–72. 1*s.* 3*d.* (Edinburgh and London: Oliver and Boyd.) [412

The New Town Hall: or Our Borough. An unconventional History of a famous Metropolitan Borough. By W. Margrie. Pp. 48. (London: The Author, 65 Trafalgar Avenue, S.E.15.) 1*s.* [412

Medical Research Council. War Memorandum No. 1: The Treatment of 'Wound Shock'. (Instructions produced by the Medical Research Committees on Traumatic Shock and on Blood Transfusion, in co-operation with the Army Medical Service.) Second edition. Pp. 32. (London: H.M. Stationery Office.) 6*d.* net. [612

National Parks: their Creation and Administration. Pp. 8. (London: Standing Committee on National Parks.) 3*d.* [712

Part-time Scientific and Technical Education. Pp. 12. (London: Association of Scientific Workers.) 3*d.* [712

Imperial Agricultural Bureaux. Cultivation and Breeding of Russian Rubber-bearing Plants. Pp. ii+53+4. (Aberystwyth: Imperial Agricultural Bureau.) 2*s.* 6*d.* [812

London Shellac Research Bureau. Technical Paper No. 25: Reconditioning of Old and Blitzed Lacs. By N. R. Kamath and Dr. B. S. Gidvani. Pp. 20. (London: London Shellac Research Bureau.) [812

Transactions of the Royal Society of Edinburgh. Vol. 61, Part 2, No. 10: The Genus Primula, Section Petiolares. By Sir W. Wright Smith and Dr. H. R. Fletcher. Pp. 271–314. 11*s.* Vol. 61, Part 2, No. 11: A Previllous Human Ovum, Aged Nine to Ten Days (the Davies-Harding Ovum). By Dr. Francis Davies. Pp. 315–326+2 plates. 4*s.* (Edinburgh and London: Oliver and Boyd.) [1112

British Empire Cancer Campaign. Twenty-first Annual Report, 1944. Edited by J. P. Lockhart-Mummery. Pp. 96. (London: British Empire Cancer Campaign.) [1212

Experimental and Research Station, Nursery and Market G... Industries' Development Society, Ltd. Twenty-ninth ... 1943. Pp. 77. (Cheshunt: Nursery and Market Gar... Development Society, Ltd.)

Philosophical Transactions of the Royal Society of London... A: Mathematical and Physical Sciences. No. 792, Vol... General Motion of the Aeroplane. By S. Brodetsky. ... 8*s.* No. 809, Vol. 239: On Invariant Theory under Restri... By D. E. Littlewood. Pp. 387–417. 5*s.* (London: Camb... sity Press.)

Medical Research Council. War Memorandum No. ... Injuries: Early Diagnosis and Treatment. By the Vascular ... Sub-Committee of the M.R.C. War Wounds Committe... (London: H.M. Stationery Office.) 4*d.* net.

National Institute of Agricultural Engineering. P... 504/44: Annual Report for the Year ending August 3... 16. (Askham Brian, York: National Institute of Agric... eering.) 3*d.*

Science and the Real Freedoms. Pp. 16. (London: ... Scientific Workers.) 3*d.*

Ministry of Agriculture and Fisheries. Bulletin No. 1... By Dr. H. V. Taylor and E. E. Skillman. Pp. 24+6 plates. ... H.M. Stationery Office.) 9*d.* net.

Ministry of Education. Community Centres. Pp. 40. ... H.M. Stationery Office.) 9*d.* net.

The Natural Resources of Ireland. A series of Discourses ... before the Royal Dublin Society on April 12th, 13th and 1... in commemoration of the Centenary of the publication b... of Sir Robert Kane's "The Industrial Resources of Ireland" (Dublin: Royal Dublin Society.) 2*s.* 6*d.*

### Other Countries

Smithsonian Miscellaneous Collections. Vol. 104, No. 8: ... Shipworm from the Panama Canal. By Paul Bartsch. (Pu... 3774.) Pp. ii+4+1 plate. (Washington, D.C.: Smithsonian ... tion.)

Proceedings of the United States National Museum. Vol. ... 3177: Parasitic Copepods in the United States National ... By Charles Branch Wilson. Pp. 529–582+plates 20–... No. 3179: A Collection of Birds from Northern Guan... Rica. By Alexander Wetmore. Pp. 25–80+plates 3–6. ... D.C.: Government Printing Office.)

Proceedings of the United States National Museum. ... 3181: The Fishes of the Family Characinidae from Ve... Descriptions of Seventeen New Forms. By Leonard P. ... 235–368. (Washington, D.C.: Government Printing Office.)

Indian Lac Research Institute. Bulletin No. 56: ... Storage on Lac. By M. Rangaswami and S. C. De. Pp. ... Bulletin No. 57: Lac-melanine and Lac-melanine ... Resins. By Y. Sankaranarayanan and H. K. Sen. Pp. ... (Namkum, Ranchi: Indian Lac Research Institute.)

Proceedings of the United States National Museum. Vol. ... 3182: New Genera and Species of Oriental and Australian ... Bugs in the United States National Museum. By Tsai-Yu ... Pp. 369–396. (Washington, D.C.: Government Printing Office.)

The South African Frog (*Xenopus lævis*) in Pregnancy Di... A Research Bulletin by Dr. Abner I. Weisman and Christo... Coates. Pp. xiv+134. Supplement: Queries relating to ... *lævis.* Pp. 12. (New York: New York Biologic Research ... tion.)

Yale University School of Medicine. Second Annual R... the Historical Library, 30 June 1942. Pp. 81. (New Haven... Yale University School of Medicine.)

Nyasaland Protectorate. Annual Report of the Forestry D... for the Year ended 31st December 1943. Pp. 12. (Zomba: ... ment Printer.) 1*s.*

Commonwealth of Australia: Council for Scientific and I... Research. Bulletin 179: Lubrication Between the Piston ... Cylinder Wall of a Running Engine. By J. S. Court... and G. K. Tudor. Pp. 24+9 plates. (Melbourne: Go... Printer.)

Publications of the Dominion Observatory, Ottawa. ... Bibliography of Seismology. No. 15: Items 5674–5787. ... June 1944. By Ernest A. Hodgson. Pp. 251–268. (Ottaw... Printer.) 25 cents.

Indian Forest Leaflet No. 67: Some Groundnut Pr... Formulae and their Application. By D. Narayanamurti... 4 annas; 5*d.* Indian Forest Leaflet No. 68: Note on Sap... its Prevention. By D. Narayanamurti and J. N. Pande. ... 6 annas; 7*d.* (Dehra Dun: Forest Research Institute.)

Smithsonian Miscellaneous Collections. Vol. 104, N... Feeding Apparatus of Biting and Sucking Insects affecti... Animals. By R. E. Snodgrass. (Publication 3773.) P... (Washington, D.C.: Smithsonian Institution.)

Kungl. Svenska Vetenskapsakademiens Handlingar. ... Band 21, No. 2: Zur Kenntnis der Morphologie, Enzystie... Taxonomie von Dinophilus. Von Gösta Jägersten. Pp. 90+... Serien 3, Band 21, No. 3: On the Dermal Bone, Sensor... and Pit-lines of the Skull in *Eusthenopteron foordi* Whiteaves, ... some Remarks on *E. säve-söderberghi* Jarvik. By Eric Jarvik. ... (Stockholm: Almquist and Wiksells Boktryckeri A.-B.)

Sociedad Nacional Agraria: Institute of Cotton Gene... No. 1: The Selection Experiment with Peruvian Ta... By Sydney Cross Harland. Pp. 98. (Lima: Socie... Agraria.)

United States Department of Agriculture. Leaflet ... Spruce Budworm. By R. C. Brown. Pp. ii+4. (Was... Government Printing Office.)

Commonwealth of Australia: Council for Scientific ... Research. Bulletin 177: A Soil Map of Australia. ... Prescott. Pp. 15+map. (Melbourne: Government Pr...

Cooper Union for the Advancement of Science ... Director's Report for the Eighty-fifth Year en... Pp. 34. (New York: Cooper Union.)